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SHIP APPLIED FIRE ENGINEERING (SAFE) USER MANUAL Version 2.2

A Computer Model for the Implementation of The Ship Fire Safety Engineering Methodology (SFSEM)

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16. Abstract

In order to conduct a thorough fire safety analysis, the analyst must mix both theory and experience. The Ship Fire Safety Engineering Methodology (SFSEM) is the theory, but in order to utilize it successfully, the analyst must have a significant knowledge of the ship being analyzed as well as experience in fire protection.

The SFSEM for fire safety can be utilized to perform a comprehensive fire safety analysis of a ship design or of an existing ship. The SFSEM evaluates the probability of spaces and barriers successfully limiting a fire on a compartment-by-compartment basis. The evaluation incorporates fire growth hazard potential, automatic detection, fixed and manual suppression, and barriers. The system is structured in a manner that allows probable paths of fire propagation to be determined based on time durations.

The Ship Applied Fire Engineering (SAFE) programming system automates portions of the SFSEM. It is actually an integrated series of programs requiring engineering evaluations, ship geometry, and ship features as input. SAFE enables a person to describe the layout of a ship through AutoCAD, enter data values for compartments and barriers into a database, and run a probabilistic fire model on the ship. These data values, as well as results of running the probabilisitic model, can be output in text or graphic form.

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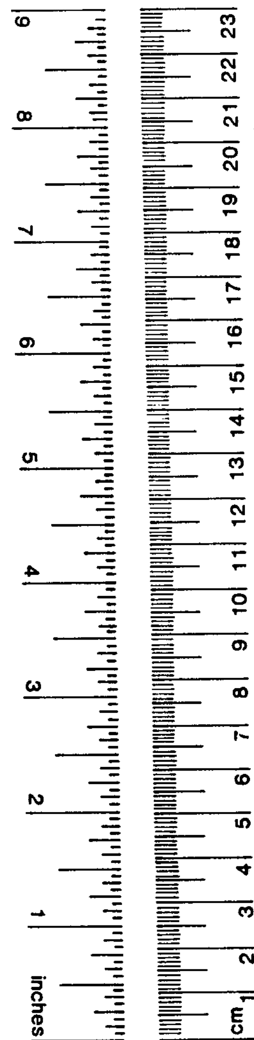
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

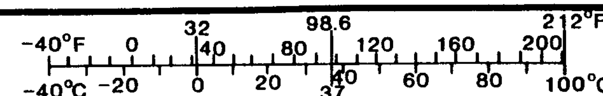
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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DISCLAIMER

The programs described in this report are furnished by the government and are accepted and used by any recipient with the express understanding that the United States Government makes no warranty, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information and data contained in this program or furnished in connection therewith, and the United States shall be under no liability whatsoever to any person by reason of any use made thereof. These programs belong to the government. Therefore, the recipient further agrees not to assert any proprietary rights therein or to represent these programs to anyone as other than government programs. Any commercial products or tradenames mentioned in this report are included for informational purposes only, and do not constitute an endorsement or recommendation by the United States Coast Guard.

SAFE is intended primarily for use in ship design and alterations. Users are warned that SAFE is intended for use only by persons competent in the field of fire safety applied to marine vehicles and is intended only to supplement the informed judgement of the qualified user. The SAFE software package is a computer model which, when used outside of its intended scope, may or may not have predictive value when applied to a specific set of factual circumstances and which could lead to erroneous conclusions if not properly evaluated by an informed user.

PREFACE

A. CHAPTER OVERVIEW

The overall fire safety of a ship is not obvious. It is dependent on many factors, including the vast number of fire scenarios that are possible. To perform a fire safety analysis, a means is required to evaluate a ship for the many fire scenarios to which it may be subjected. The analysis should be able to show what would happen if various alternatives such as better fire boundaries or improved fire detection had been used. In other words, a means of modeling fires on ships is required which accounts for all of the relevant aspects in an integrated framework. The Ship Fire Safety Engineering Methodology (SFSEM) provides the basis for such a probabilistic model and the Ship Applied Fire Engineering program (SAFE) is its computerized implementation.

SAFE is not intended to be used by everyone. It was designed with a specific user in mind, and its value is dependent on the knowledge and experience of that user.

B. SAFE REQUIREMENTS

B.1. User Requirements

The SAFE user should be a fire protection engineer with ship-board experience or a Naval Engineer with fire protection experience. The user should also have academic knowledge of the graduate level course "Building Fire Safety Analysis" taught at Worcester Polytechnic Institute, Worcester, MA. The user should have read *The Theoretical Basis of the Ship Fire Safety Engineering Methodology* by C.M. Sprague [1] supplied with this User Manual and herein referred to as *Theoretical Basis*. The user is expected to be familiar with IBM-compatible PC's and MS-DOS version 5.0 or higher. SAFE also involves using AutoCAD Release 11 or greater. While AutoCAD expertise is not required, it is recommended that preparing the ship general arrangement deck plans in AutoCAD (Chapter III) be done by an experienced AutoCAD user. Chapter IV also requires a certain amount of AutoCAD "literacy," at least a working knowledge of the AutoCAD commands listed in Appendix M.

B.2. Ship Limitations

There are some limitations set on the size of the ship which can be analyzed, the number of model runs that can be done, and the number of data sets that can be saved. These restrictions are necessary but were determined arbitrarily and can be increased by the SAFE programming team if the need arises. Contact SAFE HELP if there is a need to increase these limitations.

Maximum number of:

Compartments: 450	Model Runs: 500
Barriers: 2500	Data Sets: 100
Decks: 9	

B.3. System Requirements

The following minimum equipment is required:

- IBM-compatible, 80386 computer with math co-processor and MS-DOS 5.0 or greater.
- 13 MB of disk space. *
- 8 MB of RAM
- 590K free conventional memory. This is discussed in Section I.D.3.1.
- AutoDESK's AutoCAD Release 11 or greater, installed on the computer.
- All essential hardware and software required to run AutoCAD.
- Pen plotter or color printer for color graphics and printer for black/white graphics and reports.

* The INFORMIX package requires about 3 MB. SAFE files will take up approximately 6 MB, and the files generated by SAFE for a ship will take additional megabytes of disk space.

Note: In order to print SAFE reports correctly, printer form length should be set to 66 lines/page and the printer's symbol set should be the standard graphic character set where Hex codes C0 - DF are line draw composite characters. See Appendix P for a more complete explanation of how to ensure SAFE's printed output will be properly formatted.

In addition, installation of an electronic spreadsheet is recommended. To aid in the analysis, a number of database reports are available for export to and manipulation in a spreadsheet.

Chapter I. INTRODUCTION AND INSTALLATION

A. CHAPTER OVERVIEW

In order to conduct a thorough fire safety analysis, the analyst must mix both theory and experience. The Ship Fire Safety Engineering Methodology (SFSEM) is the theory, but in order to utilize it successfully, the analyst must have a significant knowledge of the ship being analyzed as well as experience in fire protection.

B. INTRODUCTION TO SFSEM

The SFSEM for fire safety analysis can be utilized to perform a comprehensive fire safety analysis of a ship design or of an existing ship. The SFSEM evaluates the probability of spaces and barriers successfully limiting a fire on a compartment-by-compartment basis. The evaluation incorporates fire growth hazard potential, automatic detection, fixed and manual suppression, and barriers. The system is structured in a manner that allows probable paths of fire propagation to be determined based on time durations.

C. INTRODUCTION TO SAFE

The Ship Applied Fire Engineering (SAFE) programming system automates portions of the SFSEM. It is actually an integrated series of programs requiring engineering evaluations, ship geometry, and ship features as input. SAFE enables a person to describe the layout of a ship through AutoCAD, enter data values for compartments and barriers into a database, and run a probabilistic fire model on the ship. These data values, as well as results of running the probabilistic model, can be output in text or graphic form.

SAFE Version 1.0 was a group of programs utilized on an HP-UX system to perform a fire safety analysis of the Polar Icebreaker Replacement Design in October 1987.

SAFE Version 2.0, the first integrated package for IBM-compatible computers and released in 1992, was used to analyze three small cutters in classes 65 WYTL, 75 WLIC, and 110 WPB.

SAFE Version 2.1, released in January 1994, was used to analyze six more small cutters in classes 65 WLI, 65 WLR, 75 WLR, 82 WPB, 100 WLIC, and 100 WSES, and one medium cutter in class 175 WLM.

SAFE Version 2.2 described in this manual is a further refinement of SAFE 2.0 and was used in 1994-1995 to analyze the 224' USCGC Vindicator (COMEC 3).

C.1. Discussion of Approach

As mentioned above, SAFE employs both AutoCAD (the Coast Guard's standard CAD tool) and an external database in order to organize the large amounts of data required to perform a fire analysis adequately, to provide a user-friendly and manageable means of data entry, and to display the results of the analysis in a meaningful manner. AutoCAD was chosen as the graphics interface because of its extensive capabilities. It is hoped that most ships to be analyzed will already be drawn in AutoCAD to facilitate the time and accuracy needed for geometry entry. Provided in this manual is a rather detailed description of a method for modifying these deck plans so they can be utilized by SAFE. Should AutoCAD deck plans not be available, a brief description of a method for manually entering deck plans in AutoCAD is also given.

C.2. Procedure for Detailed Fire Safety Analysis of a Ship

A fire safety analysis of a ship using SAFE is only as good as the data entered into SAFE and the forethought put into developing a comprehensive plan for modeling. Dedicating a reasonable amount of time and planning these steps is the only way to ensure that the results produced are meaningful. This section imparts some of the knowledge gained by the developers of SAFE while performing fire safety analyses of twelve Coast Guard cutter classes.

The time it takes to conduct a fire safety analysis from start to finish varies with the size of the ship, the amount of cooperation received from the ship's crew or designer/builders, the time spent arranging and completing the ship data for entry, the number of alternatives considered during modeling, the quality of the cost-benefit analysis conducted, and whether a formal final report of the analysis is to be written.

The procedure for a detailed fire safety analysis of a ship is outlined in the following eight steps:

C.2.1. Load the ship's geometry into the database and generate the ship visit forms. This step encompasses Chapter III and Chapter IV through Section IV.C.3. The resulting ship's geometry may be modified, if necessary, after the **recommended ship visit** discussed below in step 2. While input from the analyst may be required to make certain decisions about the modeling of the ship plans, most of this process can be handled by a support person familiar with AutoCAD and personal computers.

C.2.2. Conduct the recommended ship visit (Section IV.C.3). It is highly recommended that the engineer/analyst personally visit the ship. If the analysis is being conducted on a preliminary design, a similar existing ship should be visited. The quality of the fire safety analysis is directly proportional to the quality of the information obtained during this ship visit. During the ship visit, the engineer should:

- Complete the ship visit forms and verify all information for accuracy.
- Photograph all compartments to document fuel loads, unusual fire protection features, accesses, ventilation openings, etc.
- If possible, conduct an "in port" fire drill and note the time to set condition ZEBRA.
- Obtain copies of the Main Space Fire Doctrine, Casualty Control Manual, and a complete set of the Compartment Check Off Lists if previously unable to do so.
- Discuss with the Commanding Officer (CO) or Operations Officer (OPS) the various missions of the ship and which compartments contain support equipment for these missions. This information will aid in setting realistic Fire Safety Objectives (FSO's).
- Discuss with the Damage Control Assistant (or alternatively, the CO or Engineer Officer) the state of the crew's firefighting training. Specifically note the general condition of the ship (clean/dirty) and the attitude of the crew. These factors will be used when determining certain values which are assigned by engineering judgement.

C.2.3. Enter values into SAFE. This step includes refining the ship's geometry with new information gathered during the ship visit (Section IV.C.3.5), determining/calculating all required fire parameters, performing the data entry required to transfer the information from the ship visit forms into SAFE, and verifying the accuracy of the data entry. This encompasses the balance of Chapter IV. The engineer will be responsible for determining the final fire parameter values but data entry can be handled by support personnel. When this step is finished, the values in the database comprise a "baseline data set" for the ship.

C.2.4. Run model using standard scenarios and optimal run time for baseline data set. The baseline data set is intended to represent the ship with its existing passive, automated, and manual firefighting systems in effect. A scenario refers to the modeling options set for one run of SAFE's probabilistic model. Run time for a model run may be from 5 to 120 minutes. The goal of this step is to determine the run time at which the rate of increase in Relative Loss Factors (RLF) for most compartments levels off, then to run a set of 12 standard and non-standard scenarios on the baseline data set for the optimal run time. The results of these scenarios on the baseline data set will be used to judge whether an improvement to the ship is necessary to improve its fire safety. Optimal run time refers to the shortest model time that yields accurate RLF values to conserve computing resources.

Section V.H.8 discusses this step in more specific detail.

C.2.5. Analyze the baseline fire protection levels of the ship. The results of the scenarios in step 4 must be examined to determine how well the ship meets its FSO's. A compartment with an RLF greater than 1.0 indicates that compartment does not meet its FSO's and an improvement in fire protection is indicated. A RLF less than 1.0 indicates a compartment exceeds its FSO's.

There are at least three possible reasons that a compartment does not meet FSO's:

- The target compartment itself lacks adequate fire protection.
- Another compartment is primarily responsible for fires that spread and ultimately involve the target compartment.
- FSO's for the target compartment were not set properly (i.e. too high a level of safety).

Determining the cause for each failed compartment may involve examining detailed reports from the model run, running the standard scenarios with different output options or varying levels of automated and/or manual firefighting systems in effect. Once the scenario options have been determined by the engineer for each model run, it may be more expedient to have support personnel run the required models and turn the results over to the engineer for analysis.

C.2.6. Analyze alternative recommendations. To alleviate problems identified in step 5, the engineer should consider alternatives which are consistent with goals set by the sponsor. For example, the following goals were established for the first three small cutters analyzed:

- Reduce dependence on manual firefighting efforts
- Improve fire protection so that all compartments meet their FSO's.

These goals were achieved by running scenarios with the manual firefighting option "turned off", then modifying the baseline data set with alternatives that would enhance passive fire protection and automated suppression to determine if they would be equivalent to the contribution provided by manual firefighting. This step can be a protracted exercise but should be continued until the goals of the analysis are satisfied or until all reasonable alternatives have been analyzed (Chapter V). Again, once the desired changes to the data set and scenario options have been determined for the model runs required to analyze each alternative, support personnel can run the required models and turn over the results to the engineer for analysis.

C.2.7. Conduct a cost-benefit analysis. A weight or volume benefit analysis could also be conducted depending on sponsor requirements. The benefit of each alternative is determined by comparing the change to the RLF's caused by the modification. The cost of an alternative should consider the direct and indirect costs of implementing the change.

C.2.8. Document the fire safety analysis. A report should document the baseline analysis and the consideration of all alternatives. Reports from SAFE can be generated and included to provide supporting data. The cost-benefit analysis should be documented in the same report. Graphic reports from SAFE can significantly enhance the report (Chapter VI). Once all required SAFE reports have been generated, the ship's data and results should be 'archived', (removed from the SAFE database, Chapter VII) to prepare for the analysis of the next ship.

C.3. Metric vs English Units

In general, input to and output from SAFE are in the units most widely accepted in the United States for a given parameter. Length, area, volume and fuel weight are input in English units while barrier material properties of thermal conductivity, density, specific heat and thickness are recorded in metric units since that is how they are generally available. In all cases, the required units are provided for a given parameter and any conversions that must be performed are invisible to the user.

C.4. Documentation Guidance

Successful use of SAFE requires that the user closely follow instructions provided by this *SAFE User Manual* and that the user have a thorough understanding of the SFSEM as documented in the *Theoretical Basis*. The user will often be referred to the *Theoretical Basis* for documentation of algorithms and formulas used to calculate or assign values to certain variables used by SAFE.

Many sections of the *SAFE User Manual* contain items marked NOTE:, CAUTION:, and/or WATCH FOR:. These are important. Be sure these are read and understood before the section is begun. It is always recommended to read each section thoroughly before undertaking the task it describes.

C.4.1. User Manual Conventions

In general, Chapters I and II are introductory information, and Chapters III through VII correspond to the five "SAFE Main Menu" options, with section titles matching the options on sub-menus whenever appropriate. The appendices are an integral part of SAFE documentation and are referred to frequently.

Chapters are labeled with Roman numerals, sections by capital letters, parts and sub-parts by numbers. The chapter number is only included if the section is in another chapter. For example, a reference to Section C, Part 2, Sub-part 1 of Chapter III made from another chapter would be written 'Section III.C.2.1'. If referenced from within Chapter III, it would be written simply 'Section C.2.1'. A general reference to a chapter, however, would be written 'Chapter IV'.

Titles of chapters or sections will be printed in double quotes. References to SAFE menu option titles are also surrounded by quotes; i.e., "Prepare AutoCAD Drawing".

Prompts for user input from any of the components of SAFE and AutoCAD commands are printed as **BOLD CAPITAL LETTERS**. The phrase "**COMMAND:** prompt" refers to the AutoCAD prompt.

Data to be typed in by the user is printed as **bold text**.

<enter> refers to the RETURN or ENTER key on the computer keyboard. This convention is used for any single key; **<F1>**, etc.

<ctrl-c>, etc. refers to holding down the first key, Ctrl, while pressing the second key, c. This convention is used for any combination of keys; **<alt-F4>**, etc.

C.5. General SAFE Program Guidance

SAFE has three interfaces with which the user must be familiar: Menus, AutoCAD, Database Entry Screens.

C.5.1. Menus

SAFE is a menu-driven program. Appendix O contains a complete drawing of the program flow. The following is a typical menu:

Assign & Tailor Barrier Values:
a. Review/Add Barrier Materials...
b. Assign Barrier Materials...
c. Enter Openings/Tailor Barriers in AutoCAD
d. View/Print Current Barrier Values
Return to Previous Menu
Xit SAFE
U.M. IV.C.5

A menu option that will display a submenu is followed by "...". Whenever necessary, SAFE menus provide a "Return to Previous Menu" option and, if possible without interfering with the program flow, an "Xit SAFE" option used to exit SAFE completely and return to the DOS prompt. Each major menu screen displays a reference to the chapter of the *SAFE User Manual* documenting the options on that screen. For example, on the lower left corner of the menu screen, "U.M. IV.C.5" refers to Chapter IV, Section C.5 of the *SAFE User Manual*.

There are two methods available for making a menu selection:

- When one menu choice has a highlighted bar, the arrow keys may be used to move the highlighted bar to the desired option, then pressing **<enter>** activates the option.
- Whether a highlighted bar exists or not, typing the letter displayed in bright cyan which precedes the selection activates that selection; **<a>**,**<b>**,... for the major options, **<r>** for "Return to Previous Menu", **<x>** for "Xit SAFE", **<y>** for "YES:..." etc. In general, the letter to press is displayed at the beginning of each menu option. Do NOT press **<enter>** after pressing the letter.

NOTE: Some of the procedures called by the menus are slow to display to the screen. DO NOT hit any keys while waiting for SAFE to respond. Extra keystrokes might be returned to the menu when the current choice is complete, resulting in unintentional selection of menu options.

Screen colors reflect the following categories:

- Menus and sub-menus are blue with a dull cyan border. Menu choice names are usually in white text, titles and information in bright cyan. The menu choice names generally correspond to the section titles of the *SAFE User Manual.*

- Information screens are blue with a white border, with white text. Key words may appear in yellow, red, or green. Some screens prompt the user to press **<enter>** to continue, while others remain on the screen for a few seconds before continuing with no user response.

- Warning or error screens are red with a white border. Text is white, and key words may appear in yellow or bright cyan. These screens are important - they warn of some lack, error, or inconsistency found during the current procedure. The user must take care to read these carefully and refer to the *SAFE User Manual* for guidance.

- A blank blue screen with a "Working. . ." message indicates that database processing is taking place. When the "Working. . ." message appears near the bottom of the screen, expect it to march its way to the top before disappearing. When the "Working. . ." message appears in mid-screen, it should remain there until database processing is complete and the next screen appears.

- On rare occasions, a blank blue screen with no message indicates that database processing is taking place. Do not press any keys until a menu reappears.

C.5.2. AutoCAD

Appendix M describes the use of AutoCAD Release 11 (and greater) in SAFE by listing the standard AutoCAD commands employed by SAFE, describing AutoCAD .dwg files included with SAFE, and briefly documenting the special SAFE AutoCAD utilities included in the package. In general it is assumed that the user is AutoCAD "literate" and will utilize the *AutoCAD Reference Manual* for information on unfamiliar commands. It is recommended that Appendix M be read before beginning Chapter III.

C.5.3. Database Entry Screens

SAFE utilizes a relational database, Informix-4GL. Entry screens have been designed to be user-friendly. Each screen provides directions on its specific use, but the following features apply to all entry screens:

- The Escape key, **<esc>**, will save changes made to the database and exit the screen.
- Depressing **<ctrl-c>** will discard changes and exit the screen.
- Highlighted boxes are used to indicate where entries can be typed on a screen.
- Arrow keys are used to move between lighted boxes and scroll through lists of selections.
- Function keys **<F1>** through **<F8>** may be utilized to bring up windows which provide more information or to activate certain other functions as explained in the specific directions on each screen.
- **<Page Up>** and **<Page Down>** keys are useful for displaying the previous or next screens of information if any exist.

C.6. SAFE Program Organization

The executable code for SAFE is stored in \SAFE and \SAFE\BIN with initial files to load into the database stored in \SAFE\BIN\LOAD.

Files for a demo ship are stored in \SAFE\DEMO, \SAFE\DEMO\SET-1, \SAFE\DEMO\SS, and \SAFE\DEMO\FINAL.

As the SAFE program is run, its output files are stored in \SAFE\IO, \SAFE\SAFE.DBS, and \SAFE\WHATIF.

For each analyzed ship, a directory is created: \SAFE*code* with *code* being the unique code assigned by the user when a new ship is to be analyzed.

When the data set is modified and the model is run, its results are stored in \SAFE*code*\SET-*#*.

Any results able to be imported into an electronic spreadsheet are stored in \SAFE*code*\SS. When the ship is archived, all its data is stored in \SAFE*code*\FINAL.

NOTE:
The successful execution of SAFE requires that these files be created, updated or deleted ONLY by the SAFE program.

The user must NOT make any changes to the SAFE program files from the DOS prompt level. The ONLY exceptions to this rule are outlined in Chapter IV (redo geometry using .SAV files) and Section VII.B.2 (archiving ship information to a floppy).

D. INSTALL AND INITIALIZE SAFE

The installation procedure consists of three parts: installing the run-time Informix database, installing the SAFE program, and creating a link between AutoCAD and SAFE. AutoCAD should already be installed and configured on the computer.

NOTE: "Drive" or "hard disk" refers to a hard-disk partition; C:, D:, etc. "Floppy drive" or "diskette" refers to a 3.5" or 5.25" drive/disk.

Before installing INFORMIX or SAFE, decide on which drive SAFE is to be installed. The default for INFORMIX installation is C:. There is no default for SAFE installation, but SAFE must be installed directly under the root directory of the chosen drive. The drive and path of the AutoCAD directory and the INFORMIX directory will be requested during SAFE installation.

D.1. Install INFORMIX Database

Included with the SAFE package is the Informix-4GL DOS RUNTIME version of the database. Follow the instructions for Standalone DOS Installation included with Informix. Changes to the Informix installation defaults are listed below. The prompt for the installation drive and directory will appear in the early part of the installation. The rest of the prompts listed will appear at the end of the installation.

PROMPTS FOR INSTALLATION (prompts in **SMALL BOLD CAPS**, user input in ***bold italics***):

> **INSTALLATION DRIVE & DIRECTORY:** ***drive:\INFORMIX***

where *drive:* is the drive where INFORMIX is to be installed. The directory must still be INFORMIX, directly under the root directory of the drive.

> **THIS INSTALLATION PROCEDURE WILL NOW ADD ENVIRONMENT VARIABLES TO YOUR AUTOEXEC.BAT AND CONFIG.SYS FILES.**
>
> **ENTER 'Y' TO RECONFIGURE OR 'N' TO SKIP THIS STEP:** ***N***

Any changes required will be accommodated by SAFE. The system variables FILES, BUFFERS, DBCOLOR, INFORMIXDIR, and PATH will be set by SAFE.

> **DO YOU WISH THIS INSTALLATION TO REQUIRE USER PASSWORD?:** ***N***

SAFE cannot use the database if it is installed with a password.

D.2. Install SAFE

The SAFE program, provided on three diskettes, uses an INSTALL program to install SAFE in a directory called SAFE directly under the root directory of whichever drive is chosen during installation. Before beginning the installation, make sure that there is not already a directory under the root directory named SAFE. If so, remove it.

It will be necessary to enter the following information during the installation:

i. the installation drive for SAFE
ii. the exact PATH (drive:\ACAD) of the main AutoCAD directory
iii. the exact PATH (drive:\INFORMIX) of the main Informix directory (from Section D.1)

To begin:

- Insert SAFE diskette #1 in the floppy drive
- Type **A: <enter>** (or **B: <enter>**) to change to the floppy drive.
- Type **INSTALL <enter>** at the A:> or B:> prompt.
- Supply requested information (see above) when prompted.
- Remove diskette #1 and insert diskette #2, then #3 when prompted.

The first screen describes the information SAFE will require during installation. The installation program will create all necessary directories and copy all files to the correct directories.

The installation also creates a file called SETUP which sets the DOS PATH and other system variables each time SAFE is called. This file is saved to SAFE diskette #1 (installation) as well as placed in the \SAFE directory. If this file is lost or corrupted it can be re-copied to the \SAFE directory from SAFE diskette #1.

If there is a problem during installation and the installation is aborted, delete all files or directories found under the \SAFE directory, then remove the \SAFE directory itself before attempting to install SAFE again.

D.3. System Setup for SAFE

This section addresses two important steps in configuring the computer system to run with SAFE:

i. Meeting SAFE's conventional memory requirements.

ii. Providing SAFE with AutoCAD setup information.

Step ii, discussed in Section D.3.2, is required for all systems. Step i, Section D.3.1, may already be complete for some systems, and will be discussed first.

D.3.1. SAFE's Memory Requirements

SAFE is a memory-intensive application, requiring a minimum of 590K free conventional memory (with MS-DOS **PRINT** installed). The first step is to determine the amount of free conventional memory and to see what is loaded on the freshly-booted system. Then adjustments to the system may be made until a minimum of 590K is free when the system is rebooted and DOS **PRINT** is loaded.

To check the status of conventional memory, use the MS-DOS 5.0 **MEM** command with the **/C** option, or the **MAM** utility (provided with SAFE in the \SAFE directory). It is best to check the amount of available conventional memory on a freshly-rebooted system. If the system has 590K with DOS **PRINT** installed, SAFE may be run with the system as is (see NOTE below). If less than 590K is free, memory-resident TSR's (loaded by AUTOEXEC.BAT or a menu program) and/or device drivers (installed in CONFIG.SYS) must be removed before running SAFE. Be sure to SAVE your original AUTOEXEC.BAT and CONFIG.SYS before editing!

NOTE: The system's video display ADI driver and other AutoCAD environment variables such as ACADCFG and ACAD should not be loaded/set until AutoCAD is called by SAFE. These will be added to SAFE in Section D.3.2 below and should be removed from CONFIG.SYS and AUTOEXEC.BAT in this step. However, any memory managers required for operation of AutoCAD (HIMEM.SYS, QEMM programs) should remain in AUTOEXEC.BAT and CONFIG.SYS files.

It is impossible to address every system and the possible ways to free up conventional memory, but the general rule is to create a bare-bones AUTOEXEC.BAT (and CONFIG.SYS, if necessary) to remove any memory-resident programs (TSR's) or device drivers (**DEVICE=**) which are not absolutely required by the system's hardware. If the system has an advanced graphics card, that device driver might be required.

SAFE does require that ANSI.SYS be loaded in CONFIG.SYS and DOS **PRINT** be installed in AUTOEXEC.BAT. It is also recommended to load DOS HIGH to free up conventional memory and use a disk cache program such as SMARTDRV (Microsoft) or CACHE (Compaq) to increase operating speed of SAFE. See the bare-bones examples below. In some cases, however, the database entry screens may freeze up if a disk cache is used. In that case, try reducing the size of the cache or removing it altogether.

If there are TSR's loaded automatically by a menu program or batch file other than AUTOEXEC.BAT, simply removing the call to the batch file or menu program from AUTOEXEC.BAT may be sufficient.

Begin by removing TSR's and/or menu programs or batch files from AUTOEXEC.BAT (see bare-bones file below). Add the line **PRINT /D:PRN > nul** if it is not already in AUTOEXEC.BAT. Add the line **DEVICE=C:\DOS\ANSI.SYS** (as shown below) if it is not currently included in CONFIG.SYS. Reboot the system. Check the amount of free conventional memory. If it still falls below the 590K limit, a bare-bones CONFIG.SYS must be created also (see below). In this new CONFIG.SYS, be sure to eliminate any unnecessary **DEVICE=** commands since each device installed uses precious conventional memory.

The only commands required by SAFE in AUTOEXEC.BAT and CONFIG.SYS are:

AUTOEXEC.BAT

```
@echo off
path c:\;c:\dos {the root dir. and DOS directory of the system}
prompt $p$g     {any prompt will do}
print /d:prn > nul
```

CONFIG.SYS

```
device=c:\dos\himem.exe          {recommended}
dos=high                         {recommended}
device=c:\dos\smartdrv.exe       {disk caching - recommended}
device=c:\dos\ansi.sys
files=60
shell=command.com /p /e:1024     {may be needed. See Section E}
(include advanced graphics device if necessary)
```

Be sure to substitute the correct pathnames for your system.

These two short files may function as a complete bare-bones SAFE setup for your system. Note the minimal path set in AUTOEXEC.BAT. It is important to keep the path as short as possible, limiting it to only the directories absolutely required for the operation of SAFE.

To ensure sufficient conventional memory for SAFE, available memory is checked by SAFE each time SAFE is run. If there is not enough conventional memory available, a message screen will appear listing items loaded in conventional memory and referring the user to this section. If that message screen appears, SAFE will not run until more conventional memory is made available by rebooting with a bare-bones setup.

It can be tedious to switch between the original and bare-bones setups if the system is often used for applications other than SAFE. This process may be automated somewhat by creating a DOS batch file to handle the copying of files as shown below.

In this example, the SAFE bare-bones files are created in the root directory (C:\) with the names AUTOEXEC.SAF and CONFIG.SAF. The batch file, SAFESET.BAT, saves the original AUTOEXEC.BAT and CONFIG.SYS with an .ORG extension, then copies the .SAF files to AUTOEXEC.BAT and CONFIG.SYS. The system may then be rebooted, which will install the bare-bones (.SAF) setup. SAFESET.BAT then copies the .ORG files back to AUTOEXEC.BAT and CONFIG.SYS so the system will be returned to the original setup next time the system is booted.

To use this method:

Create CONFIG.SAF and AUTOEXEC.SAF using the guidelines above, adding the following line to AUTOEXEC.SAF:

```
presafe
```

Create PRESAFE.BAT to return the .ORG files to their original names:

```
@echo off
copy config.org config.sys > nul
copy autoexec.org autoexec.bat > nul
echo The system will be returned to its original setup with the next reboot.
pause
cls
```

Create SAFESET.BAT:

```
@echo off
copy config.saf config.sys > nul
copy autoexec.saf autoexec.bat > nul
echo SAFE setup ready.  Ensure printer is on.  Reboot at will...
```

Type **SAFESET** at the DOS prompt to execute the batch file, then reboot at the prompt. The system will then be ready to run SAFE when Section D.3.2 has been completed. The PRESAFE.BAT file called by AUTOEXEC.SAF will ensure that the system returns to its original configuration upon the NEXT reboot.

D.3.2. SAFE's AutoCAD Setup

SAFE received the AutoCAD path during installation. The computer system's video display ADI driver and pointing device driver (if not provided by AutoCAD) and other AutoCAD environment variables such as ACADCFG and ACAD will not be loaded/set until AutoCAD is called by SAFE since SAFE requires as much free conventional memory as possible. It is therefore necessary to provide SAFE with the system-specific information to perform this AutoCAD setup each time AutoCAD is called by SAFE. It is assumed that SAFE will not be run from any external menu program or batch file. SAFE requires SETUP.BAT, SHUTDOWN.BAT, DRIVER.BAT, and UDRIVER.BAT to exist before SAFE is run.

The AutoCAD environment variables must be added to the SAFE files SETUP.BAT and SHUTDOWN.BAT created during SAFE installation. These files contain system-specific information to ensure SAFE, Informix, and AutoCAD can communicate.

If the video display ADI driver and/or pointing device driver are not provided by AutoCAD, they will be loaded before each call to AutoCAD and unloaded each time AutoCAD is exited to ensure maximum available memory at all times. To handle this, the two DOS batch files (DRIVER.BAT, UDRIVER.BAT) must be edited to contain the load and unload commands for the system's ADI drivers. This includes mouse drivers, since the only portion of SAFE that supports a mouse is AutoCAD. NOTE: SAFE depends upon the existence of DRIVER.BAT and UDRIVER.BAT even if they are not needed to load or unload the driver.

Examine the computer system's program or batch file that contains the system's AutoCAD setup routine.

Edit SETUP.BAT using an ASCII editor and add the necessary environment variables and other DOS commands, EXCLUDING the ADI drivers. Remember that the PATH to AutoCAD was provided during installation. DO NOT alter ANY of the commands already in SETUP.BAT! This file is called immediately whenever SAFE is run and sets all necessary system variables for SAFE.

NOTE: The 'after editing' sample files below show SETUP.BAT and SHUTDOWN.BAT for a Compaq system running AutoCAD Release 11 which is installed in D:\ACAD.

<u>SETUP.BAT before editing:</u>

```
set savepath=%path%
path=d:\safe;d:\acad;%path%
set informixdir=d:\safe\informix
set dbpath=d:\safe
set dbcolor=blue
```

<u>after editing:</u>

```
set savepath=%path%
path=d:\safe;d:\acad;%path%
set informixdir=d:\safe\informix
set dbpath=d:\safe
set dbcolor=blue
set acad=d:\acad;d:\acad\support
set acadcfg=d:\acad
```

Edit SHUTDOWN.BAT and add commands to reset the system variables set in SETUP.BAT to "blank" (e.g., **SET ACADCFG=**). Again, DO NOT alter ANY of the commands already in SHUTDOWN.BAT. This file is called immediately before SAFE exits to DOS to ensure the system is restored to its original condition.

SHUTDOWN.BAT before editing:	after editing:
set path=%savepath%	set path=%savepath%
set savepath=	set savepath=
set informixdir=	set informixdir=
set dbpath=	set dbpath=
set dbcolor=	set dbcolor=
	set acad=
	set acadcfg=

Edit DRIVER.BAT and UDRIVER.BAT containing the command(s) to load and unload the system's ADI drivers.The mouse driver does not have an "unload" option. This will be handled by SAFE.

NOTE: The AGACAD and AGACAD UNLOAD commands load and unload the video ADI and mouse drivers for a sample Compaq system.

DRIVER.BAT	UDRIVER.BAT:
D:\ACAD\AGACAD > nul	D:\ACAD\AGACAD UNLOAD > nul
C:\DOS\MOUSE\MOUSE > nul	

Once SETUP, SHUTDOWN, DRIVER, and UDRIVER contain all portions of the AutoCAD setup and the commands to "remove" that setup, the link from AutoCAD to SAFE is complete. Copy SETUP.BAT and SHUTDOWN.BAT to the SAFE #1 diskette as SETUP.NEW and SHUTDOWN.NEW. Copy DRIVER.BAT and UDRIVER.BAT to the SAFE #1 diskette as is.

E. HOW TO RUN SAFE

Ensure the system printer is online, ready to print, and DOS **PRINT** has been installed (AUTOEXEC.SAF). The printer must be ready with **PRINT** installed before running SAFE.

Move to the drive where \SAFE is installed, cd \SAFE, and type **SAFE** at the DOS prompt. SAFE will check available conventional memory, and if less than 590K is free, SAFE will not run. The system must be rebooted with the bare-bones setup, SAFESET.BAT, developed in Section D.3.1 before SAFE will run.

If adequate memory is available, SAFE will run. If the message "Out of Environment Space" appears on the screen when SAFE is entered, increase the system's environment space. Environment space is used to set up the system's path and variables which AutoCAD and the Informix database need. The default size of DOS's environment space is 256 bytes. If there is a line in the system's C:\CONFIG.SYS file which looks similar to this: **SHELL=COMMAND.COM /P /E:1024**, then the number following the /E is the number of bytes allocated to environment space. If the number is less than 1024, try increasing it to 1024. If that line doesn't exist in CONFIG.SYS, add it just as it appears above. Reboot the computer, change to the \SAFE directory again and try re-entering SAFE. If the message "Out of Environment Space" still exists, then the system is set up with too many applications other than SAFE which are claiming environment space. Use the bare-bones CONFIG.SAF file approach which is discussed in Section 3.1 so that only SAFE's environment variables will be consuming environment space.

When SAFE is successfully entered with no error messages, hit **<enter>** after the initial opening banner in order to display the initial menu.

When Xit SAFE is chosen from any SAFE menu, control will be returned to the DOS prompt.

Chapter II. SELECT SHIP TO ANALYZE

A. CHAPTER OVERVIEW

This menu is often referred to as the "initial menu". The options on this menu are discussed in the sections below. Once a ship has been selected from this menu, this menu will not appear again until that ship is archived and it is time to select another ship. If the demo ship is selected, this menu will not appear until the demo ship is archived.

B. ANALYZE DEMO SHIP

This option installs the demo ship, a medium cutter in class 175 WLM, in the database. This ship was chosen as the demo because its geometry illustrates many of the features of ship design that SAFE handles: 6 decks (2 below the Main) with several decks being stepped and 133 total compartments with 88 considered in the analysis. Of these compartments, several span two or more decks and several are of reduced height--some wholly enclosed in other compartments, some not.

The demo data set consists of complete working copies of an AutoCAD ship drawing and a database with all procedures of Chapters III and IV completed. All compartments and barriers on the demo ship have been assigned default fire parameter values and have been tailored slightly.

The scenarios discussed in Section V.H have been run. They represent:

i. Conditions in port, daytime (location in port, damage control condition XRAY), with snapshots of the relative loss factors at 10-minute intervals. From this information, select the optimal run time. (60 minutes was selected.)
ii. Conditions in port, daytime (location in port, damage control condition XRAY)
iii. Conditions in port, nighttime (location in port, damage control condition YOKE)
iv. Conditions at sea, peacetime (location at sea, damage control condition YOKE)

The specific modeling options used for each of these scenario will appear on the "Specify Scenario for Model Run" screen and are discussed in Section V.H. The modeling results may be printed by selecting option f., "Modeling Results", from the "View/Print Reports and Forms" menu (option b. on the Demo Main Menu).

When the demo ship is loaded in the database, the "Demo Ship Main Menu" is displayed as the first menu, offering the options to examine, alter, and run the probabilistic model on the demo data set. The values in the demo data set can be examined through reports offered on the "View/Print Reports and Forms" menu (Chapter VI). The data set can be edited and new scenarios specified for model runs. The options offered on the "Demo Ship Main Menu" are a subset of SAFE, and the *SAFE User Manual* documentation of these available options will guide the user through the demo. Options available from this demo menu are:

- "Run Probabilistic Model": See Chapter V. This chapter discusses altering the data set and scenario options available for model runs, as well as options for examining modeling results.

- "View/Print Reports and Forms": See Section IV.E and Chapter VI. This option allows a wide variety of reports from the current data set to be examined.

- "DONE: Archive Demo/Cleanup SAFE": This MUST be selected before a new ship analysis is begun so that the database can be cleared out. The process of archiving the demo is similar to the process in Chapter VII, except the option to delete the demo without saving is not available. Any changes made to the data set during analysis of the demo are not saved. The demo ship is archived in its original state.

The demo can be used over as many sessions as desired. To end a demo session without removing it from the database, choose "Xit SAFE" from the "Demo Ship Main Menu". Until the demo is archived, the "Demo Ship Main Menu" will be the first menu to appear after the introductory menu. The demo will be in the same state as it was at the end of the previous session. When completely finished with the demo, choose "DONE: Archive Demo..." to clear out the database. This must be done before analysis of another ship can begin. Once the demo is archived, the "Select Ship to Analyze" menu will reappear.

C. ENTER A NEW SHIP

This option prepares SAFE for analysis of a new ship. A screen appears requesting entry of basic ship and deck information including the following:

- Ship Proper Name - The complete name of the ship. This name will be printed at the top right corner of each report.

- CG Ship Number (optional) - The ship's hull number.

- Ship Code Name - This 3-4 character UNIQUE code should be an abbreviated version of the proper name which will be used to name various files and directories for this ship. Once this screen is exited, the code can not be changed.

- SAFE AutoCAD Plan Date - Since plans may change on design-phase ships, this date may serve to clarify the set of plans which correspond to this analysis.

- Cellulosic/Plastic Fuel Load Units - SAFE requires fuel load to be entered as cellulosics, plastics, and flammable liquids, and it combines these three components into pounds per foot^2 (psf) and then to kBTU's per foot^2. (See Section IV.C.3.3.4.) Flammable liquid fuel is always entered as total gallons per compartment; however, the user is given the option of entering cellulosic and plastic fuel load in total pounds per compartment or in psf. Enter either an "F" (to enter fuel load in pounds per FOOT^2), or a "C" (to enter total pounds per COMPARTMENT). If 'C' is chosen, values for cellulosic and plastic fuel load can not be assigned or adjusted by CUI. The choice entered will determine the heading labels on the fuel load ship visit form printed in Section IV.C.3.3.4. It will also determine the units required by the fuel load entry screen presented in Section IV.C.4.3.4.

- Number of layers below the main deck - The AutoCAD term "layer" is used throughout SAFE to connote "deck" since SHIP.DWG has one deck per layer. Enter here the number of decks whose compartments are completely enclosed within the hull BELOW the main deck. Since the main deck compartments are not within the hull, the main deck itself is not included in this count. This information will be used to distinguish between the hull and the superstructure of the ship in the database. This value may not be altered once Section IV.C.1.3, "Geometry Correct: Load Database", is finished.

The ship information above may be revised until this screen is exited. Use the arrow keys to move to the desired fields. When the data is correct, press <esc> and the SAFE Main Menu will appear.

The new database will eventually be filled with the ship's data set in Chapters III and IV, and used to run the probabilistic model in Chapter V. When this ship analysis is complete, the ship's data set may be removed from the database, and analysis of another ship can be started from this menu selection.

D. RESTORE/ANALYZE ARCHIVED SHIP

A ship (excluding the demo ship) analyzed, then archived (Chapter VII), can be reloaded from this menu. If the reloaded ship was archived before the analysis was completed, all information marking the ship's level of completeness is restored with the database, allowing entry and/or analysis to continue where it was halted. To restore an archived ship, all files associated with the ship must be in the sub-directories where they were archived. See Chapter VII for a discussion of the archive process.

Once either "Enter a New Ship" or "Restore/Analyze an Archived Ship" is selected from this menu and the database initialized, the "SAFE Main Menu" appears.

Chapters III through VII explain the five options appearing on the "SAFE Main Menu". Read through each chapter before attempting it.

Chapter III. PREPARE AUTOCAD DRAWING

This option appears on the "SAFE Main Menu".

A. CHAPTER OVERVIEW

SAFE requires an accurate picture of the ship's geometry in order to determine which compartments are connected and thus predict fire growth through the compartments. To provide this geometry, the coordinates of the corner points ("vertices"), the elevation, and the height of each compartment will be entered into a database. SAFE utilizes AutoCAD to draft a simplified version of the general arrangement deck plans of the ship so this information can be transferred by DXF files from the AutoCAD drawing to the database. This chapter covers the creation of the ship drawing in a specific format in AutoCAD and the creation of the DXF files.

A.1. AutoCAD Notes

This version of SAFE has been tested on Release 12. More recent releases should be compatible but have not been tested with SAFE.

Read Appendix M before continuing this chapter. The standard AutoCAD commands mentioned in this chapter are listed in the appendix, but in general it is assumed that the user will be AutoCAD "literate" and will refer to the *AutoCAD Reference Manual* [2] for information on unfamiliar commands. Appendix M also describes the SAFE AutoCAD utilities provided in the package. Note that many of the SAFE AutoCAD utilities are NOT to be invoked by the user, but are automatically called by SAFE at specific points. Some of the utilities are run only once per ship analysis and can cause damage if run out of sequence.

After any original AutoCAD drawing files received on diskette are plotted for use as a reference in Section C.1, it is required that AutoCAD be entered only through SAFE while working on the ship plans for SAFE, in this chapter and others. Most of the sections of this chapter mention when to enter and exit SAFE and AutoCAD. In general, in this chapter, AutoCAD and SAFE can be exited at any time and re-entered via the "Prepare AutoCAD Drawing" option from the SAFE Main Menu, as long as the drawing files are **QUIT**, **SAVEd**, or **ENDed** as requested by this manual. Reading each section before beginning should give the user a sense of when it to exit AutoCAD and SAFE during a particular procedure.

A.2. Discussion of Three Ways to Get Plans

Ship geometry can be obtained in three ways: hand-drawn ship geometry forms from actual ship visits, blueprints, or original AutoCAD deck arrangement .dwg files. Data from ship visits or blueprints must be entered in an AutoCAD drawing in a standardized format, called the ultimate drawing format, before SAFE analysis of the ship can begin. Data from original AutoCAD deck arrangement drawing files will be converted to the same ultimate drawing format through a different process.

A.3. Discussion of Ultimate Drawing Format: SHIP.DWG

The ultimate drawing format is an AutoCAD drawing file of the ship which will be called SHIP.DWG. This drawing will NOT be a detailed set of ship plans, but a concise yet precise logical representation of all compartments on the ship and their interconnections. The drawing will be a 2-D plan view of each deck with height ("thickness") and elevation added to represent the Z dimension.

In SHIP.DWG, the ship's decks will be drawn to scale, 1 unit=1 foot, with one deck on each drawing layer. Each deck is assigned a sequential number, the lowest deck being #1, and will be drawn on a layer correlating to that number so the decks appear to lie on top of each other in the drawing in the order they are on the ship, lined up vertically in correct orientation.

Each deck layer will contain the deck name, doors, windows, ladders, hatches, and the name, Plan ID, and Compartment Use Indicator (CUI) for each compartment. Each compartment is represented by a single closed polyline of a thickness equal to the average compartment height, on the appropriate deck layer at an elevation equal to the average elevation of that portion of the deck. The ship's centerline with frame ticks may be drawn on layer 0 so it may be displayed with each layer. Appendix M contains a summary of this ultimate format.

Regardless of which of the three methods was used to gather the ship's geometry, the ship drawing must be in this ultimate format in the file SHIP.DWG before beginning Chapter IV.

In all cases, the basic process to create SHIP.DWG will be:

i. Decide whether all of the ship's decks will be involved in the analysis. For most ships, all decks will be analyzed. NOTE: SAFE allows a maximum of 9 decks. On some ships, the lowest deck contains only fuel tanks, water tanks, and voids. SAFE doesn't analyze potentially explosive compartments like fuel tanks and water tanks, and voids are generally inert. Because of this, it may be possible to omit the bottom deck from the analysis if it contains no fuel load and no mission critical equipment. Additionally, the compartments on the lowest deck of a ship often are irregularly shaped and of varying heights, making them difficult to model. Omitting this deck simplifies the analysis considerably with no significant impact on the analysis results. Remember to assign the number one to the lowest deck being analyzed.

ii. Represent the ship's compartments as a collection of closed polylines of zero thickness and elevation. Adjust these polylines so that bulkheads that span more than one deck (e.g. watertight bulkheads) are located at exactly the same vertical plane on each deck. Make sure that compartments that span more than one deck are drawn on each deck where they exist and the area of their overlap between decks is accurate.

iii. Change the thickness and elevation of each compartment polyline to simulate the vertical position of the compartment on the ship.

Sections B through F in this chapter describe the process for creating SHIP.DWG in this ultimate drawing format. The method used to gather the ship's geometry determines which of the sections will be used to complete the process:

- If the ship plans are to be created in AutoCAD manually from data gathered from ship visits (Ship Geometry Forms), only Section C will be skipped.
- If the ship plans are received as blueprints and must be entered into AutoCAD manually, begin with Section B.2, skip Section C and continue with Section D.
- If ship plans are received as AutoCAD .dwg files on diskette, begin with Section C.

In all cases, Sections D through G are required. Also, a copy of the AutoCAD drawing worksheet is needed in all cases. Instructions for printing it will be given when it is needed.

B. IF NO AutoCAD DRAWINGS OF THE DECK PLANS EXIST

This section deals with the first two means of obtaining ship geometry. If no paper deck plans are available, Section B.1 describes the process of creating hand-drawn deck plans from actual ship visits. In Section B.2 SHIP.DWG will be readied for use in translating either these hand-drawn deck plans or blueprints into the ultimate format that SAFE requires.

If general ship information has not yet been entered into SAFE, refer to Section II.C for instructions on filling in the general ship information before continuing.

B.1. If No Paper Deck Plans Exist

If no blueprints for the ship exist, the ship plans must be approximated from information gathered from the ship's crew via correspondence or during a preliminary ship visit by the analyst. The Ship's Geometry Form, describing the configuration of the ship and each compartment on the ship, must be completed by the ship or the analyst. The form consists of two parts:

i. Ship's Overall Geometry Form which instructs the user to make a sketch of each deck's layout with overall dimensions and a sketch of the inboard profile of the ship to show any stepped decks.

ii. Compartment Geometry Form which requests a sketch and description of each compartment in detail, with complete measurements.

These forms will be used to create a drawing of the ship plans in the ultimate drawing format.

To obtain the forms, enter SAFE by typing **SAFE** from the \SAFE directory at the DOS prompt. From the SAFE Main Menu, choose "View/Print Reports and Forms" and select "Data Entry Worksheets and Forms". Choose option "Ship Geometry Forms" to print the forms described above. The forms are relatively self-explanatory, but must include a sufficient amount of detail to allow the ship's deck plans to be recreated in Section E.

When the ship visit is completed and the forms are filled out, continue with Section B.2.

B.2. IF Paper Plans Exist but NOT AutoCAD Drawings

If blueprints have been obtained or if the ship's geometry has been gathered as described in Section B.1, the ship plans must be translated to AutoCAD. The plans will be created directly in SHIP.DWG, which will be a copy of the prototype drawing ULTIMATE.DWG.

NOTE: Once the file SHIP.DWG is created, SAFE will automatically open that drawing when an AutoCAD function is selected from the SAFE menu. AutoCAD's Main Menu will be bypassed.

Enter the SAFE menu by typing **SAFE** at the \SAFE DOS prompt.

When the SAFE Main Menu appears, choose "View/Print Reports and Forms" from the "SAFE Main Menu" and select "Data Entry Worksheets and Forms".

Choose option "AutoCAD Drawing Worksheet" and print it, primarily for use in Sections D-G of this chapter.

Much of the information requested on this form is used in Section C and may be ignored if AutoCAD drawings of the deck plans have to be created from paper plans.

However, fill in the deck names in part 4, starting with the lowest deck being analyzed first. (Reread step i. of Section A.3 to determine if the lowest deck may be omitted from the analysis.)

Also assign the corresponding layer number from the left hand column of part 4 to each deck on the plan view plots starting at the bottom of the ship. The lowest deck with compartments being analyzed will be layer #1, the deck above will be #2, and so on, up to the highest deck with compartments. Write the layer number under the deck name on the plan view plots. Note that these numbers do not correspond to the deck level numbers incorporated into compartment Plan ID's. The function of these numbers is completely different -- these new layer numbers are used only by SAFE and will correspond to the AutoCAD layer name.

After reviewing the AutoCAD Drawing Worksheet and filling in the appropriate sections, return to the SAFE Main Menu and select "Prepare Autocad Drawing".

Release 11:
At the AutoCAD menu, choose to begin a new drawing named SHIP using the prototype ULTIMATE.DWG (located in \SAFE\BIN) by entering **SHIP=\SAFE\BIN\ULTIMATE** for name of drawing.

Release 12:
When the **COMMAND:** prompt appears, type **NEW** to display the Create New Drawing dialogue box. Enter **\SAFE\BIN\ULTIMATE.DWG** for the name of the Prototype and **SHIP.DWG** as the New Drawing Name. Click on **OK** to continue.

All Releases:
Check the limits of SHIP.DWG using the **LIMITS** command and revise them if they are inappropriate for the size of the ship. A reasonable guideline for limits is to set the origin to 0,0, the x axis to the length of the ship plus 20 feet, the y axis to .75 times the x axis. Setting appropriate limits may help speed up AutoCAD regeneration time if the drawing becomes complex. **ZOOM EXTENTS** after setting limits. Ensure the entity creation modes for elevation and thickness are both zero (**DDEMODES**).

SHIP.DWG is now ready to be used for creating the simplified deck plans necessary to conduct a SAFE analysis. Before beginning this lengthy process in Section E, skip Section C and thoroughly read Section D for guidance in modeling the deck plans for use by SAFE. AutoCAD may be exited now by typing **END** and may be re-entered through the SAFE Main Menu to draw the simplified deck plans after Section D has been carefully read.

C. IF AutoCAD DRAWINGS OF THE DECK PLANS EXIST

Original ship plans received as an AutoCAD .dwg file typically contain much more information than SAFE requires. In this section, this original drawing will be simplified to meet the requirements of the ultimate drawing format. Some portions of this section may be skipped depending on the format of the original drawing.

C.1. Utilize the Original .DWG Drawing Files

The .dwg files received on diskette often include a ship's inboard profile as well as a ship's general description. These should be plotted by AutoCAD outside of the SAFE program and referred to throughout the analysis. From the DOS prompt, copy the .dwg files containing the inboard profile, general description, and ship plans from diskette to a directory outside of the \SAFE directory of the hard drive so as not to confuse them with SHIP.DWG. Do not rename any of these .dwg files. Plot the .dwg files through AutoCAD at a scale where all details of the drawing can be clearly seen, ideally using a large plotter.

The only original ship drawing files required on the hard drive are those containing the deck plan views. The inboard profile and general description files may be deleted once printed. Keep the original .dwg drawings on diskette.

The .dwg files containing the plan views of the ship decks will be referred to in this section as the working file(s). Use the three or four character "code" utilized when ship information was provided to SAFE in Section II.C. (for example, VIG for the Vigorous) and rename the working file using this acronym. DO NOT USE "SHIP" as the acronym. If the ship's decks are contained in more than one .dwg file, use the ship code name with a 1, 2, 3.. after it to rename the files. From the DOS prompt, copy these renamed working file(s) into the \SAFE\IO directory so they can be accessed through the SAFE program and the AutoCAD utilities available through SAFE may be used to prepare the file(s) for use by SAFE.

Enter SAFE by typing SAFE from the \SAFE directory at the DOS prompt. Choose "View/Print Reports and Forms" from the "SAFE Main Menu" and select "Data Entry Worksheets and Forms". Choose option "AutoCAD Drawing Worksheet" and print it for use throughout this chapter.

Record the names of the files discussed above on the AutoCAD drawing worksheet part 1a and 1b:

i. the original plan view file(s) (stored on diskette), and

ii. the working file(s) copy on the hard disk (VIG.DWG or VIG1.DWG, VIG2.DWG, etc).

C.2. Clean the AutoCAD Working File(s)

The working file(s) need only seven types of information from the original drawings: deck names, compartment names, Plan ID's, a polyline outline of the compartment, bulkhead and deck openings, ladders, and the centerline with frame ticks and numbers. Extra data or markings can cause unnecessary confusion. The process referred to as "cleaning" the working file actually involves moving these seven types of information which SAFE needs for each deck to their own layer. If there is more than one working file, each file will contain the deck layers for only the decks contained in that file. (For example, if VIG1.dwg contains the Main Deck and the Upper Deck and VIG2.dwg contains the Lower Hold and the Upper Hold, each file will have two deck layers in it.)

Before cleaning the working file(s), ensure there are unaltered copies of the original drawings elsewhere on a diskette as described in Section C.1., "Utilize the Original .DWG Files".

C.2.1. Create and Assign Deck Layers

The working file normally has several AutoCAD layers with parts of a deck spread over the several layers. This must be modified so there is one layer for each deck, with all information from a deck that is to be used in SAFE assigned to that layer. On the plan view plots, assign a number to each deck starting with the lowest deck being analyzed. (Reread step i. of Section A.3 to determine if the lowest deck may be omitted from the analysis.) The lowest deck with compartments being analyzed will be layer #1, the deck above will be #2, and so on, up to the highest deck with compartments. Write the layer number under the deck name on the plan view plots. Note that these numbers do not correspond to the deck level numbers incorporated into compartment Plan ID's. The function of these numbers is completely different -- these new deck numbers are used only by SAFE and will correspond to the AutoCAD layer name. Create a new layer with continuous line type, color white, for each deck in this drawing file and name it the layer number assigned above (1, 2, etc.) on the plan view plots. The **DDLMODES** command is convenient to use for creating new layers.

NOTE: If a layer with the desired number already exists, use the **D1** command (SAFE utility) to display just that layer and the **MOVEIT** command (another SAFE utility) to move the entities on that layer to any other layer in the drawing.

C.2.2. Move Necessary Information to Deck Layers

When a "number" layer has been created (or emptied if it already existed) for all the decks on the ship, turn on all layers of the drawing that contain all of the information which SAFE needs for deck 1. **ZOOM** in on a segment of deck 1, and use the **CHANGE** command to select all of that segment's necessary information and move it to layer 1. Select (P)roperties and (LA)yer when prompted by the **CHANGE** command after all information is selected. Enter the layer number (1) in response to the (LA)yer selection. Zoom in on another segment of deck 1 and repeat the process until all necessary information is moved to layer 1.

DON'T MOVE:

- furniture
- plumbing, electrical, ventilation, and other system markings
- text **other than** deck name, compartment name, or Plan ID
- lifeboats, lockers, arrows, ropes, light fixtures, etc.
- drawing borders and title blocks (leave the name of the deck).
- deck openings, including bolted access plates, **other than** hatches.

MOVE:

- the centerline, frame number marks, and frame numbers
- doors, windows, hatches, and ladders
- deck names, compartment names, and Plan ID's.
- bulkheads that define a compartment's perimeter

As a general rule, if it isn't listed in the MOVE list, don't move it. The simpler the layers, the easier it will be to create the SHIP.DWG file later. Bulkheads are often drawn with thickness, i.e. multiple lines may be used to represent one bulkhead. SAFE needs one line to represent the compartment's perimeter, so it is not necessary to move all lines which represent each bulkhead. Preferably, only the outside line or the line which a compartment has in common with an adjacent compartment is the one to move. However, it is not a problem if more than one line per bulkhead is moved.

Repeat this process for all decks in this drawing file. When completed, D1 to each deck layer in turn and see if all necessary information for that deck has been moved to that layer. Figure III-1 shows a portion of the main deck of the demo ship before and after cleaning.

C.2.3. Complete Compartment Labels and Other Text

NOTE: Any text on the drawing must be UPPERCASE and none may be underscored.

Small compartments often have the compartment name and Plan ID outside with an arrow pointing to the compartment. Use the **TEXT** command to rename these entities using smaller UPPERCASE text placed inside the area, and **ERASE** the external titles and arrows. Ladder compartments will be drawn and labeled in Section E - do not add or label them here. Compartment names that begin with numerals, e.g. "8-Man Berthing", must have the numeral enclosed in parenthesis, e.g. "(8)-Man Berthing", to be recognized properly by SAFE. Plan IDs must begin with a numeral.

It is important that each line of text be sized to fit completely within the compartment polyline, without touching any other entities. Use the **SCALE** command when necessary to ensure each line of text is as large as possible yet small enough to allow it to be selected uniquely later on. The compartment text does not have to be completely legible when the entire deck is visible on the screen.

END the drawing after this process is complete for all decks in the drawing. This will be the FINAL VERSION of the working file. From the AutoCAD Main Menu, make a backup copy of this final version of the working file elsewhere on the hard disk or to a diskette.

There may be more than one final version of the working file (VIG1.dwg, VIG2.dwg, etc.). If this is the case and all of the ship's decks are not in the same file, complete this section for other decks which may be located in the other working files.

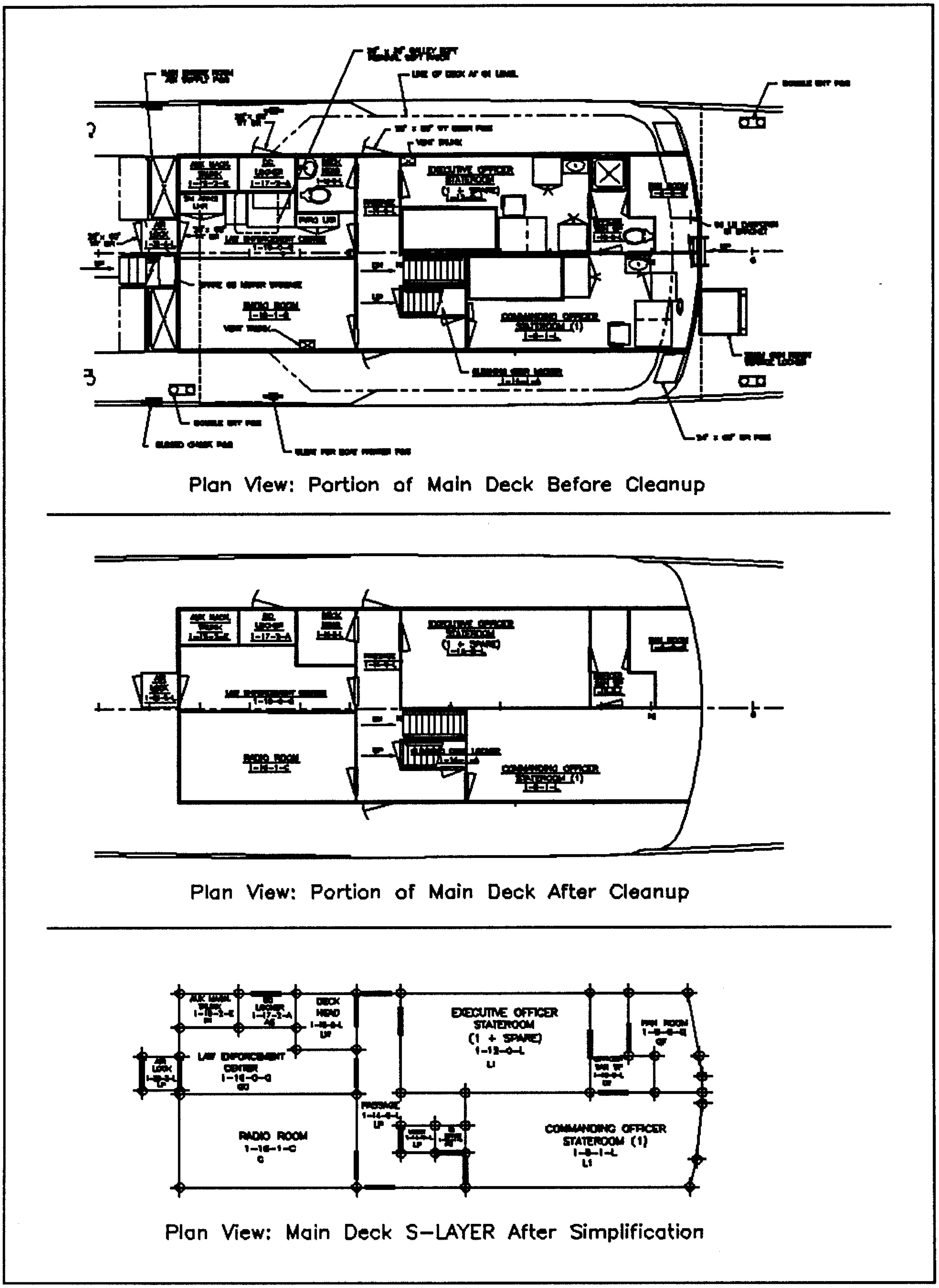


Figure III-1 Before, After Cleanup; s-layer After Simplification

C.3. Convert Plans to Ultimate Drawing Format

For ship plans received as .dwg files, it is assumed that the deck plan view drawings are not in the ultimate drawing format described in Section A.3, but instead are represented as several decks in one drawing file, lying side by side (Figure III-2) as on a drafted drawing. The decks may also be represented in several drawing files, one or two decks per file. It is also assumed that the AutoCAD working file is NOT scaled with 1 unit=1 foot, and units are displayed in architectural units. Conversion from this format to the ultimate drawing format is described in this section.

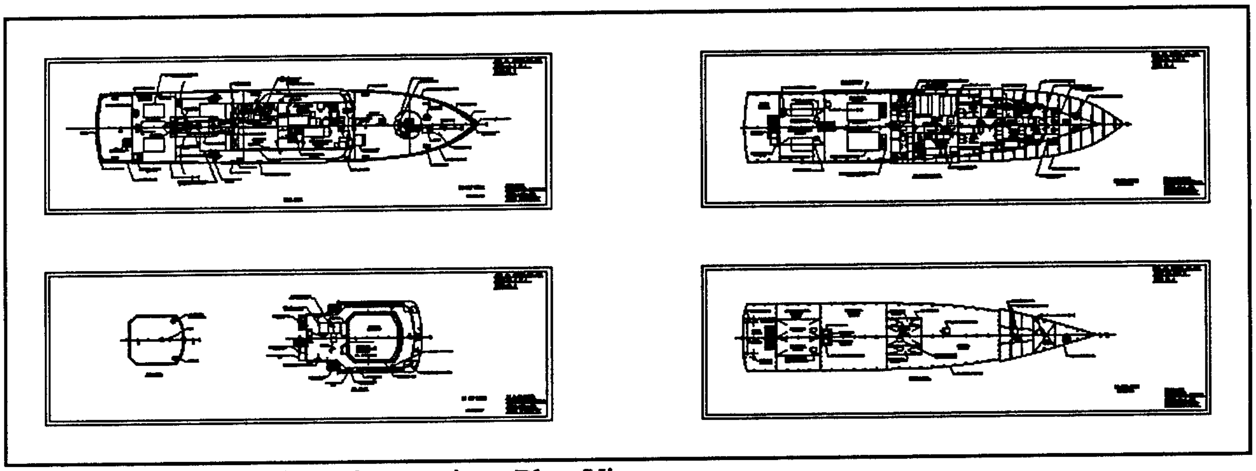


Figure III-2 Original Deck Drawing, Plan View

If the working file is already in the ultimate drawing format as described in Section A.3, skip to Section D. If the working file is in neither the ultimate format nor the assumed format, the user is left to devise a means of achieving the ultimate format. Unfortunately, there is no established convention for drawing a ship's deck plans in AutoCAD. Reading the following conversion from the assumed format may be of help in devising a non-standard conversion.

To get from the assumed format to the ultimate drawing format:

C.3.1. Derive the Scale Multiplier

Determine if the working file is scaled 1 unit = 1 foot: Find the actual overall length of the ship (from the ship's general description, if it exists) and record it on the worksheet, line 2a. Find the size of the ship in the working file by measuring the length of the longest deck on the screen. The **DIST** command with **OSNAP** option **INT** will allow accurate measurement of distances on the screen. Record this length on the worksheet, line 2b.

If this measurement is close to the ship's actual measurement then the ship is drawn to scale and drawing scale factor will be 1. If not, calculate the scale factor as follows:

actual length from line 2a / ship drawing length from line 2b

hopefully resulting in an even, or nearly even proportion factor such as 2 or 0.5. Record this scale factor (rounded) on the worksheet, line 2c.

If the drawing coordinates are displayed in feet and inches (architectural or engineering units), divide the scale factor by 12 (inches/foot) to complete the conversion to decimal feet. This result is the scale multiplier. Record this scale multiplier to four decimal places on worksheet line 2d. If the scale factor is 1 and the coordinates are in feet and inches, the scale multiplier will be simply 0.0833 (1/12).

Example:

actual ship length from general description: 120'0"
results of bow to stern measurement using **DIST** command: 59'0"
scale factor: 120/59, approx. 2 (round it)
scale multiplier: 2 / 12 = 0.1666

If the actual length of the ship is not available, the scale factor can be determined by comparing the actual number of feet between two frame ticks to the size of that frame in the working file as measured by the DIST command. The number of feet between frames can usually be found on one of the ship's profile drawings. Measure the size of a frame on the screen using the **DIST** command as above, and calculate the scale factor as follows:

actual feet per frame / DIST between two frame ticks.

The scale multiplier is then calculated as before.

CAUTION: Some ships have one frame size for one portion of the ship and a different frame size for another portion. Make sure to select the frame size which corresponds to the frames being used to determine the scale.

C.3.2. Rescale and Convert Units

If the units are already decimal feet AND the scale multiplier is 1, skip ahead to Section C.3.3.

Issue the **RESCALES** command, entering the scale multiplier from the worksheet line 2d when prompted. This SAFE utility will scale the drawing and set the drawing units to decimal feet. The drawing will be redrawn at the new scale; larger if the scale multiplier is greater that 1, smaller if the scale multiplier is less than 1.

When the **RESCALES** utility is done, **ZOOM EXTENTS** or **WINDOW** around the new ship extents. When the screen shows the new drawing area at a reasonable size, reset the working file drawing limits to fit the new drawing size. The drawing should now be 1 unit = 1 foot, in decimal feet. If there is more than one working file, complete this section for other files.

Before beginning the next section, read it through completely. It must be completed in one session, without **SAVE**ing or **END**ing. If the next section cannot be finished now, exit AutoCAD, "Xit SAFE" and begin the next section at another time.

C.3.3. Make Deck Blocks

The decks will be each written to a block file with an insertion point which will allow them to be aligned when inserted into SHIP.DWG.

DO NOT **SAVE** or **END** during this section.

When each working file's block files have been created and this section is complete, **QUIT** so the working file is left as it was at the end of the previous section.

CHAPTER III

TO BEGIN:

Identify a point that exists as an intersection of the same two lines ON ALL DECKS and that can be easily and exactly specified. This is referred to as the base point for each deck. A good candidate is the intersection of the centerline and a frame number tick that exists on all decks of the ship. It may be easier to locate this point by looking at the plan view plots rather than ZOOMing in on each deck of the drawing, especially if there is more than one working file. However, before this base point is recorded, verify that it does, in fact, exist as an intersection of two lines on each of the ship's decks. Record the location of the base point (frame number) on worksheet part 3a.

The next step is to get the X,Y coordinate of the base point on each deck. Use **ZOOM** and the **ID** command with **OSNAP INTERSECTION** to list the X,Y coordinate of each base point. Record each deck's name and the coordinate of the base point, to four decimal places, for each deck on the worksheet part 4.

ZOOM EXTENTS when the base points of all decks in this working file are recorded. Use the **D2** command and select layer 0 as the current layer and the layer to be blocked (layer 1 for this example) as the second layer. **Ensure layer 0 is current.** Create the deck blocks by issuing the **WBLOCK** command:

> **FILE NAME: 1BLK** (for deck #1, 2BLK for deck #2, etc.)
>
> **BLOCK NAME: <enter>**
>
> **INSERTION POINT:** (enter the alignment point coordinates, separated by a comma, from worksheet part 3b for the appropriate deck.)
>
> **SELECT OBJECTS: W** (window around the entire deck, including the deck name)

The lowest deck will be removed from the screen and written to disk as a file 1BLK.DWG if this process is executed correctly. If not, use the **OOPS** command to undo the **WBLOCK** command or simply redo the process and the file given will be overwritten with the corrected block.

When finished, repeat for each deck in this working file, remembering to **D2** to layer 0 as the current layer and the layer to be blocked as the second layer. **QUIT** the working drawing without saving so that the working file is left intact, simplified, in correct units. Repeat for decks in any other working files.

C.3.4. Insert Deck Blocks in SHIP.DWG

Now there should reside in the \SAFE\IO directory a .dwg file for each deck on the ship. From within AutoCAD, create the new drawing SHIP.DWG using ULTIMATE.DWG (located in the \SAFE\BIN directory) as the "pattern" or "prototype" file. See Section B.2 for instruction on using a prototype file with both AutoCAD Releases 11 and 12.

Calculate the required drawing limits for the ship and record on the worksheet, lines 5a and 5b. The origin will be 0,0, the X axis will be the length of the ship plus 20 feet, the Y axis will be 0.75 times that. If the current limits set in SHIP.DWG (X=120, Y=90) are enormously huge or too small, use **LIMITS** to reset the limits using the calculated values from lines 5a and 5b. For example, if the ship is 140 feet long, set the upper right limits to 160, 120. Then **ZOOM ALL**.

Determine the desired location of the insertion point for the deck blocks in SHIP.DWG. The point should be in approximately the same position in proportion to the ship as was the alignment point in the working file. For example, if the alignment point was located approximately in the center of the ship, choose a point in the middle of the screen.

Toggle **SNAP ON** (**<F9>**) then use the **ID** command to list the coordinates of the insertion point. Record the coordinates, with all decimal places displayed, on worksheet line 5c.

Using **DDLMODES**, **THAW** all layers with layer 0 current. Issue the **INSERT** command:

BLOCK NAME: 1BLK

INSERTION POINT: (enter the insertion point coordinates from worksheet part 5c)

Accept the defaults for scale. If the bow of the ship was not pointing to the right of the working file, enter a 180° rotation angle when prompted to point the bow of the deck to the right of the drawing.

Repeat the INSERT command for each of the deck blocks, using the same insertion point from worksheet part 5c.

After all deck blocks are inserted, it is important to zoom in on the insertion point and ensure that the base points on all decks line up. It is possible to use the **MOVE** command to bring each deck's base point exactly in line with the base point on another deck. This must be done BEFORE the decks are exploded. To do this use **ZOOM** and the **ID** command with **OSNAP INTERSECTION** to list the X,Y coordinate of the base point of the deck needing to be moved and the base point of the deck which will remain stationary. Record the coordinate of each base point, to four decimal places. Issue the **MOVE** command, select the deck block to be moved, enter its base point's coordinates for Base Point and the stationary deck's base point as the Second Point of Displacement.

When all decks exactly line up along the insertion point, **DI** each layer and ensure each deck is on the proper layer. Then **EXPLODE** each layer's block back into entities and **END** this drawing.

D. REVIEW PLAN VIEW PLOTS

The general arrangement deck plans of the ship, whether received as blueprints, drawn by hand in Section B, or plotted from AutoCAD drawing files Section C, must be carefully reviewed. Many decisions must be made as to how to model the compartments on the ship.

Color coding the paper plan view plots will help to ensure a complete AutoCAD representation of the ship. Highlight all compartment ID's on the plan view plot of each deck. Mark all main watertight bulkheads as well. Highlight doors, windows, and hatches.

D.1. Discussion of Compartment Representation

The database will use the coordinates from the compartment polylines in SHIP.DWG to calculate the connections between compartments on the ship. It is therefore crucial that each and every compartment polyline represent the compartment on the ship as accurately as possible with respect to the compartment's size and connections with other compartments. The following sections describe the methods for drawing the ship's compartment polylines correctly in SHIP.DWG.

To depict the ship's geometry for SAFE, accurately yet simply, it is often necessary to model certain areas on a ship as compartments even though they are not designated as such on the original plans. With this in mind, some decisions need to be made as to what constitutes a compartment for the SAFE analysis and what does not. In general, the definition from the "Naval Engineering Manual" [3] applies: "All compartments and spaces that are completely bounded by water-tight, oil-tight, air-tight or fume-tight bulkheads shall be numbered." There are, of course, some additions to this rule - such as compartments that are surrounded by bulkheads with an open doorway at one end or compartments divided into two for convenience. A closet or locker is considered a compartment if it is constructed as such, not if it is a stand alone locker placed in a compartment.

The following sections describe some common problems encountered when modeling compartments.

D.1.1. Ladders

Appendix K contains a complete discussion of SAFE's treatment of ladders. Read Appendix K and determine the classification of all ladders on the ship so that they may be correctly drawn in SHIP.DWG in Section E. Record each ladder's classification on the plan view plots. Plan ID's will be assigned to ladder compartments later in Section E.2.

D.1.2. Nested Compartments

To calculate compartment connections correctly, it is necessary to determine which compartments on the ship are "nested" and which are merely adjacent. The term "nested" is used to describe one compartment completely enclosed within another, with no common bulkheads. Figure III-3a shows three compartments nested in the Lazarette. Note that the tanks share no barriers with the enclosing compartment; none of the tank vertices touch the outer compartment's polyline. These tanks may either be the same height as their enclosing compartment or of reduced height. This is the only case where compartment polylines should be drawn as nested compartments, one polyline within another. For EVERY OTHER CASE, the compartments are called "adjacent" and must be modeled as adjoining compartments possibly of a reduced-height. Reduced-height compartments will be assigned the appropriate height on the paper plans in Section D.5. and in the drawing in Section F.3.

Examine the ship geometry forms or blueprints and determine which, if any, compartments on the ship are truly nested, using the guidelines below. Some common examples of adjacent compartments and their correct representation in SHIP.DWG are shown in Figures III-3b through III-3d. The "exploded" views will aid in drawing the compartment polylines in Section E.2.

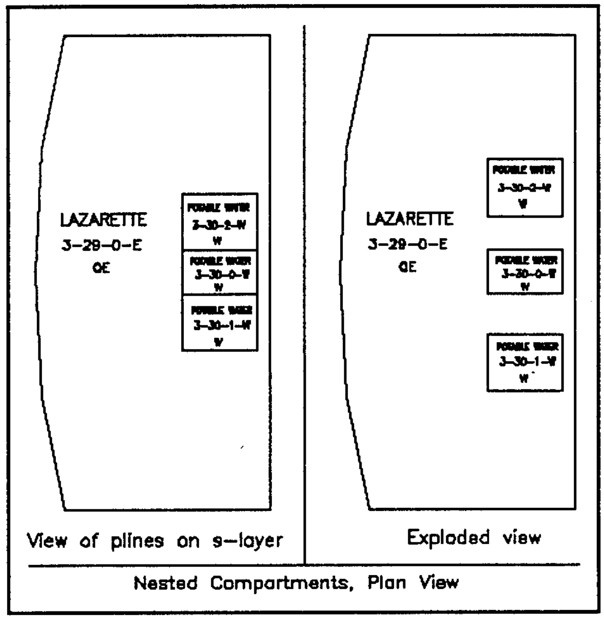


Figure III-3a Nested Compartments

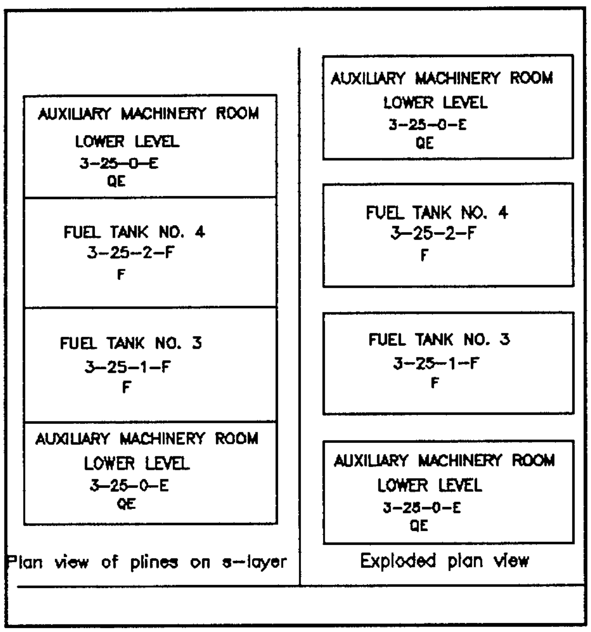


Figure III-3b Adjacent Compartments

Figure III-3b shows two tanks enclosed within an auxiliary machinery room. These tanks are NOT true nested compartments since they share vertices and barriers with the outer compartment. In this case, this section of the deck will be drawn as four separate polylines, sharing the three interior barriers and their vertices. The two outer sections will be combined in the database with the rest of the auxiliary machinery room on the deck above and the two tanks will be "inside" that space even though the compartment polylines were not drawn as nested compartments. Because the tanks are the same height as the auxiliary machinery room on this layer, they are not even considered to be reduced-height compartments. The auxiliary machinery room is an example of a multi-level compartment which is modeled in SAFE by being drawn on each layer where it exists. (See Section D.1.3.) In this case, it will be represented by three polylines, two on this layer and one on the layer above which will span the tanks to connect the two outer sections on this layer.

Figure III-3c represents a common occurrence on ships. This figure can represent a small tank at one end of an engineering space, a vestibule between two compartments, or even a ladder compartment (see Appendix K, types III and IV) in a passageway. None of these are nested compartments, and the polyline representation is always the same, as shown. The outer compartment polyline is drawn around the other compartment, sharing the appropriate vertices and barriers.

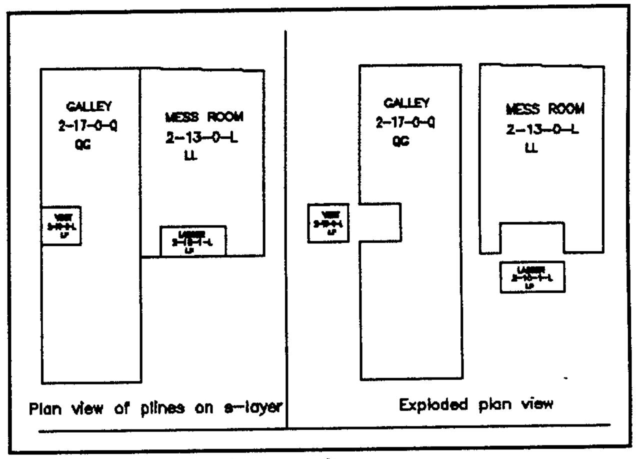


Figure III-3c Adjacent Compartments

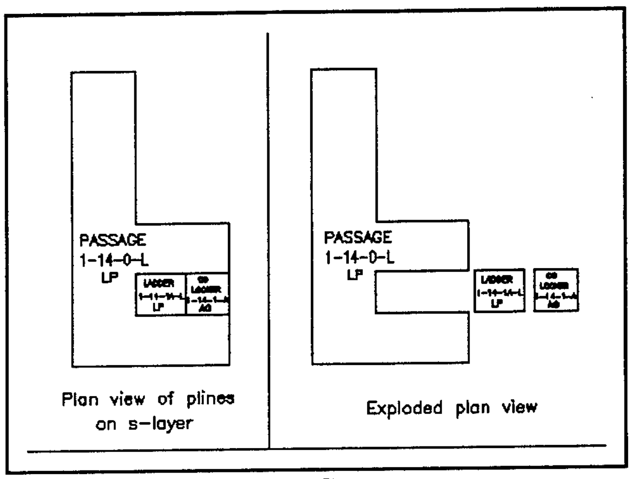


Figure III-3d Adjacent Compartments

Figure III-3d handles the case where a ladder compartment has a small compartment, usually a gear locker, in the dead space under the ladder. The gear locker would later be assigned a reduced height in Section F.3 and the left-over volume will be combined with the ladder compartment by SAFE as shown in Figure III-7. At this stage, it is sufficient to draw the three compartments shown in Figure III-3d as distinct adjacent compartments. Appendix K describes the method for drawing this construction in SHIP.DWG.

D.1.3. Multi-Level Compartments

Compartments which extend through more than one level, regardless of the number of levels they span, will be eventually considered as a single compartment with the elevation of its lowest level and a height equal to the sum of its thicknesses on each level. The compartment is represented on each deck where it occurs by a polyline to which the elevation and thickness of the compartment on that deck is added. This polyline must overlap, at least in part, its representation on all decks where it is present. The Plan ID assigned to the compartment must be the same on all levels and should reflect its lowest level. The exception is an Engine Room with an uptake that extends through additional levels. Because the uptake is generally much smaller than the Engine Room, it should be modeled as a separate compartment with its own Plan ID on its lowest level and with zero-strength overheads, if appropriate.

A multi-level compartment, such as the Auxiliary Machinery Space in Figure III-3b, may be divided on the lower deck but will eventually be combined with its representation on the deck above to form one multi-level compartment in the database. Both portions of this type of compartment on the lower level, as well as the portion on the upper level, must have the same compartment name and Plan ID assigned. The database will combine these three portions into one compartment based on the fact that they share the same Plan ID and the upper level polyline overlaps the two polylines on the lower level.

D.1.4. Subdivided Compartments

Some compartments may be modeled more accurately if they are split into two separate compartments. This decision is based primarily on the shape of the compartment and the size and dispersion of its fuel load. The two separate compartments will be connected by a zero-strength barrier. There is no difference between regular bulkheads and zero-strength barriers when the compartment polylines are drawn -- the zero-strength designation is made later when the barrier is assigned a barrier material. It is important to record the desired location of zero-strength barriers on the worksheet as mentioned below.

Following are two examples where the user may choose to assign a zero-strength barrier to subdivide a compartment:

i. A compartment may be so extensive and convoluted that it is desirable to break it into two or more smaller compartments connected by zero-strength barriers. A passageway is a common example of this type of compartment. By subdividing it, a fire in one part of the compartment will not immediately allow fire spread to a compartment adjoining a distant part of this compartment. If there is a significant fuel load in one portion of this extensive compartment and no fuel in the remainder of the compartment, breaking the compartment in two is especially recommended. In fact, SAFE will not allow a compartment with more than 30 vertices. This is a rare occurrence, but one that requires the compartment to be subdivided by zero-strength barriers.

ii. A compartment that has two or more areas with differing functions, disparate fuel loads, etc. can be made into two separate compartments separated by a zero-strength barrier so the areas can be assigned different fire parameters.

Figure III-5 shows a mess area and galley semi-divided by a partition. By adding a zero-strength barrier to divide the compartment into two, each can be given a separate compartment use indicator (CUI) in Section D.3 to reflect its different use. Also, since a compartment's perimeter must be a closed polyline in SAFE, the original interior partition dividing the areas would be disregarded if the areas were drawn as one compartment. The subdivision of the areas into two compartments allows the inclusion of this partition.

SPECIAL NOTE:

A particular type of passageway, shown in Figure III-4, poses a special problem.

If drawn as in Figure III-4 (a), it would actually be represented as two nested compartments which would cause inaccurate compartment volumes and barrier connections to be calculated by SAFE.

To prevent this, this type of passageway must be handled as two separate compartments separated by zero-strength barriers, as shown in Figure III-4 (b).

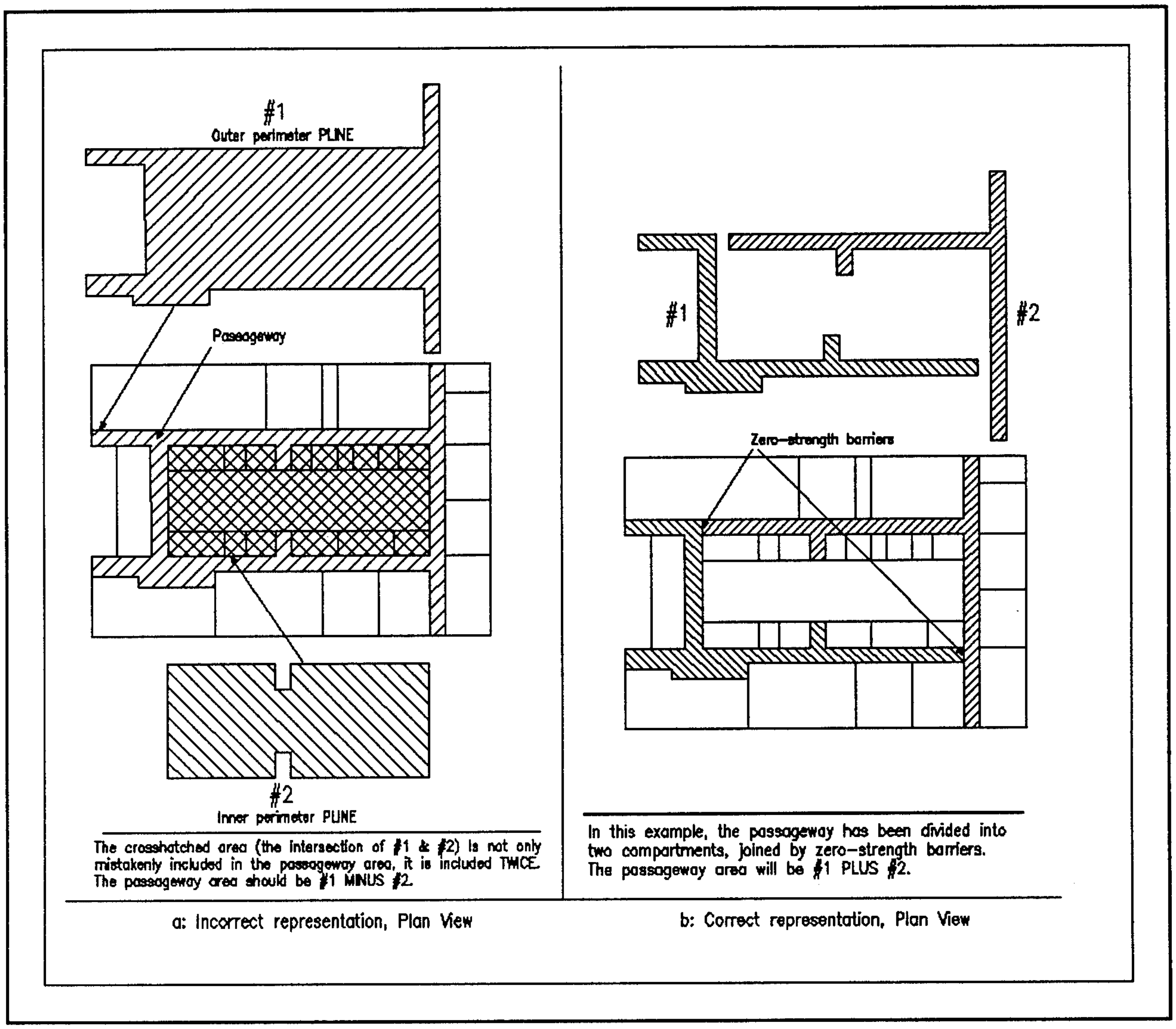


Figure III-4 Subdividing a Convoluted Passageway

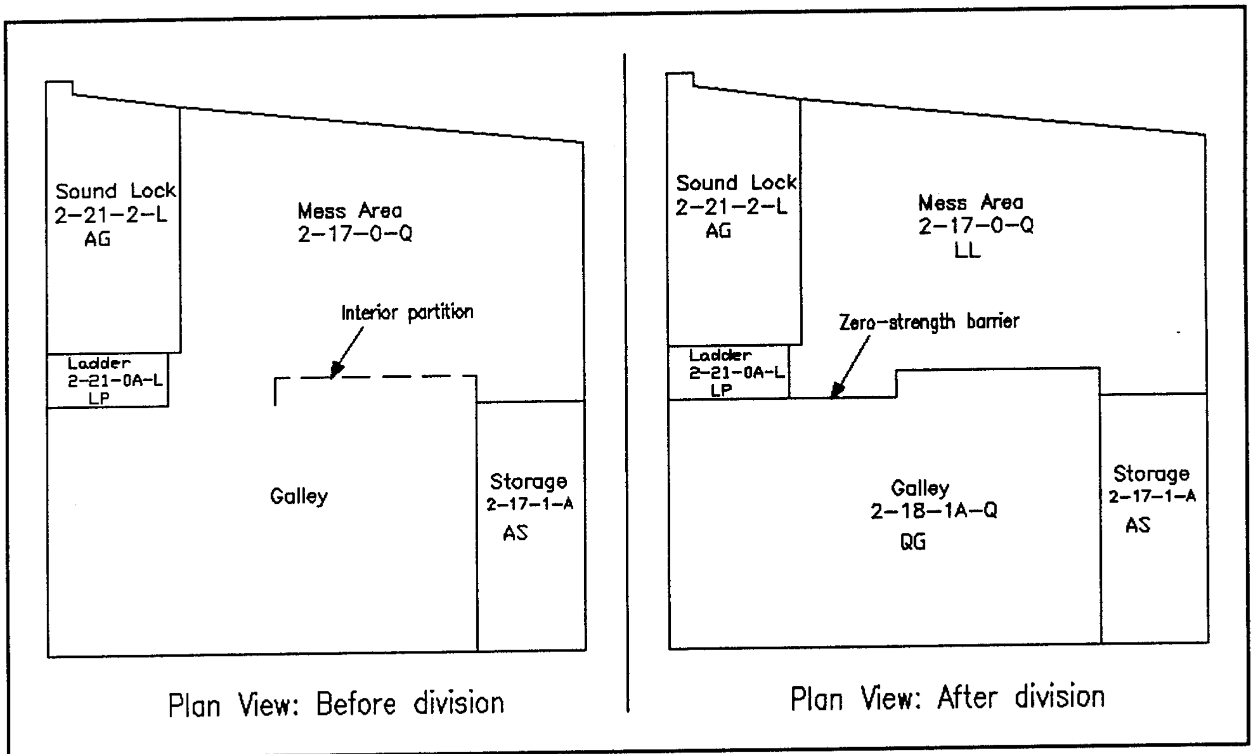


Figure III-5 Subdividing a Compartment with differing functions

Draw in and label any zero-strength bulkheads on the plan view plots, and record the two compartments adjoining each zero-strength bulkhead on the worksheet part 6. Be sure to note on the worksheet any zero-strength overheads or decks where uptakes connect to Engine Rooms.

If a compartment has been subdivided into two or more compartments, each new compartment must be assigned its own Plan ID.

D.2. Review Compartment Plan IDs

On the plan view plots, assign a name and Plan ID (refer to Appendix I) to any compartments lacking them, including Engine Room uptakes, ladders modeled as compartments (type III and IV), closets to be modeled as compartments, and subdivided compartments. If a compartment has been added for modeling purposes (ladders of type III and IV, for example), add an extra letter to the port-starboard indicator in that compartment's Plan ID as described at the end of Appendix I in order to make it unique. If an error is discovered in the Plan ID assigned to a compartment by its designers, a decision must be made as to whether to correct it or not. Correcting the Plan ID may make it more difficult for those familiar with the ship to locate the compartment being referenced in the analysis, while not correcting it will make it more difficult for the analysts to locate the compartment. If a compartment with a corrected Plan ID spans more than one deck, correct it on the plan view plots of all the decks. The Plan ID must be unique to its compartment and consistent throughout all separate portions of that compartment.

Once it is certain that all compartments have been identified on the plan view plots, count the total number of compartment Plan IDs on each deck and record the number on the worksheet part 4. Include the ladders modeled as compartments and any other new compartments in this count. Also, count compartments that span more than one deck as a compartment on each deck they span. They will not be combined by the database until later.

D.3. Assign Compartment Use Indicators (CUI's)

An additional parameter must be assigned to each compartment: the compartment use indicator (CUI). The CUI is used to define the type or function of the compartment and to establish default values for various compartment parameters. Refer to Appendices F and H to assign a CUI to each compartment with a Plan ID and record it on the plan view plots under the Plan ID. The CUI will generally begin with the same letter as the general use indicator that is often in the Plan ID, but not always. Since the CUI will be used to assign at least one fire parameter (Frequency of Established Burning) and potentially many parameters, make sure the assignment is made with respect to the compartment's use, regardless of the general use indicator contained in the Plan ID. Note that compartments given CUI's of F, J, M, and QH are potentially explosive and aren't analyzed in SAFE.

D.4. Determine Elevation and Thickness of Ship "Segments"

SHIP.DWG will not be a 3-D solid model, but rather a 2-D drawing with elevation and thickness added to the compartment polylines. This will give the height of the compartment and the location of significant "steps", or jogs, in decks to the database. However, incorporating every single variation in deck elevation or compartment height into SHIP.DWG would create a drawing much more complex than SAFE requires. It is necessary to represent only the average height and elevation of each compartment.

By viewing a profile drawing of the ship, it is usually fairly obvious which regions of each deck share the same average compartment height and elevation. Each of these regions will be called a "segment". Only the bow, stern, or a step in the deck may be boundaries of a segment. Each compartment may belong to only one segment. Compartments, such as a locker under a ladder (a reduced-height compartment), shorter than the rest of the compartments in a segment will have the reduced height entered.

A step is a change in the elevation of a deck at a frame that causes vertical connections between compartments on two different decks. A step of less than 0.5 foot in a deck is not significant to SAFE. A deck that slopes gradually from bow to stern, with no significant steps, should use the deck's average elevation for the whole deck, averaging out the slope.

The goal in segmenting a ship is to assign a realistic compartment height and elevation to each segment and to reduced-height compartment exceptions within each segment, rounded to the nearest 0.5 foot, while incorporating all significant steps and maintaining an accurate logical representation in the drawing of connections between compartments on the ship. Refer to Figure III-6a and III-6b for examples of two ships and their segments. There may be more than one acceptable segmentation of a ship, depending on which steps are deemed significant and whether all compartments are to be included in the drawing. In Figure III-6a, the 1 foot step at frame 9 is included since the compartment joining barrier a. in the Hold is to be modeled as hazardous storage. The connection between these two compartments is thus significant due to the fire path that may result from the connection. In Figure III-6b, the step at frame 10 is ignored, since the two compartments on the lowest deck are fuel tanks, and fuel tanks are not included in an analysis. Trade-offs between desired compartment heights and elevations are also evident in the two examples.

There are three types of bulkheads which may be created by segmentation. Examples of these barriers are labeled a, b, and c in Figure III-6a and III-6b:

a. Interior bulkheads connecting compartments on two different layers.
b. Exterior bulkheads caused by "splitting" a bulkhead along a step.
c. Exterior barriers below the main deck (on the hull). These do not actually exist on the ship, but are a result of averaging the slope of sloping hulls in SHIP.DWG.

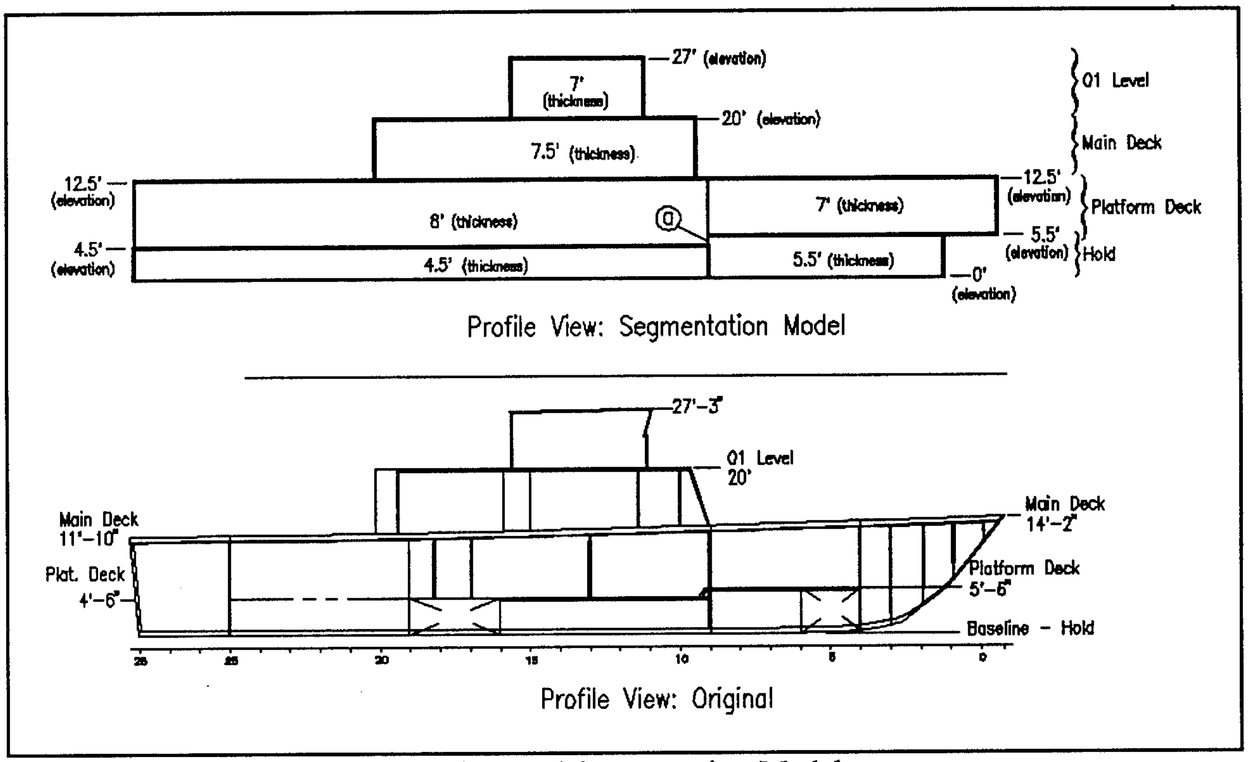


Figure III-6a Profile View 1: Original and Segmentation Model

Review the plan view plots, profile drawings (if available), and any other supporting materials to determine the ship's segments, their elevation, and their thickness (height). Round elevations and thicknesses to the nearest 0.5 foot, ensuring there are no gaps between segments on adjoining decks (see SEGMENTATION NOTES below). It may be helpful to draw a simple sketch resembling the segmented examples in Figure III-6a and III-6b, labeled with the appropriate values. Mark the frames representing the boundaries of each segment on each affected deck of the plan view plots to identify which compartments are included in each segment.

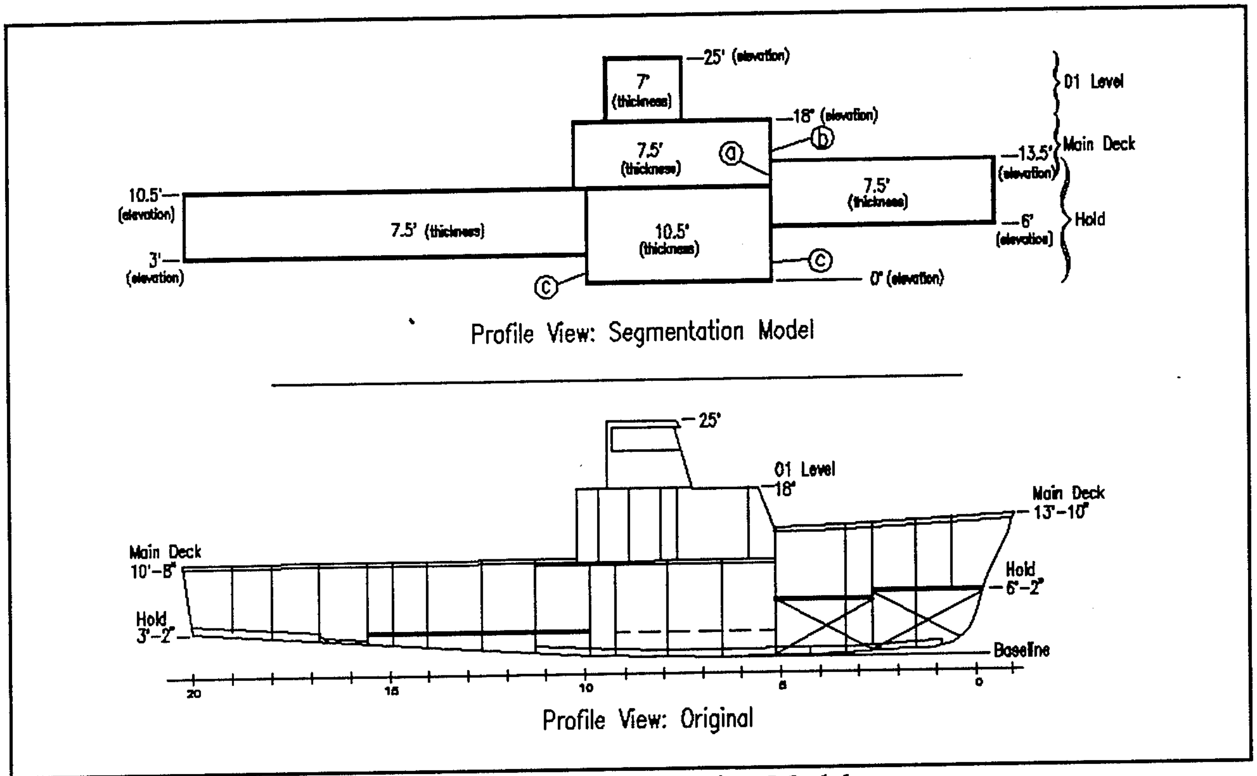


Figure III-6b Profile View 2: Original and Segmentation Model

SEGMENTATION NOTES:

- There can be NO gaps between segments. Each segment's elevation plus thickness (segment height) MUST equal the elevation of the segment directly above it (on the next s-layer). This is made much simpler and more accurate if all elevations and thicknesses are rounded to the nearest 0.5 foot.

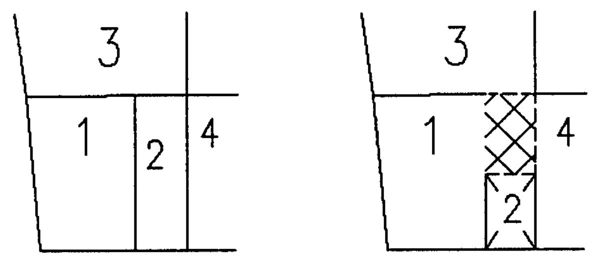
- Elevations are cumulative from 0.0 feet. Thicknesses are relative, beginning from the elevation of the polyline.

Elevation and thickness will be added to the compartment polylines in SHIP.DWG in Section F.3 after the compartment polylines are reviewed and adjusted.

D.5. Identify Reduced-Height Compartments

Compartments, such as a locker under a ladder or a small tank enclosed in an engineering space, are called "reduced-height" compartments. The reduced height (thickness) of such compartments should now be assigned. When the ship's geometry is created in Chapter IV, the reduced-height compartments and their enclosing compartments are verified.

Figure III-7 shows a profile view of a reduced-height compartment (#2) before and after its height is reduced. After its height is reduced, compartment #2's overhead connection with #3 is reassigned to #1, a new overhead connection between #1 and #2 is created, as well as new bulkhead connections from #1 to #4 and to any other compartments adjacent to #2. This, in effect, "subtracts" the excess volume from compartment #2 and "adds" it to compartment #1. The actual reassignment and creation of the barriers is automatically handled by SAFE.



Profile View:
As modeled before entering the reduced-height exception for compt. #2.

Profile View: After height is reduced.
Hatched area is 'subtracted' from compt. #2 and 'added' to compt #1.
New & reassigned barriers are shown as dashed lines.

Figure III-7 Reduced-Height Compartment Profile View

NOTE: A compartment contained within a multi-level compartment is only considered to be reduced-height if its height is less than the height of the enclosing compartment <u>on that level</u>. For example, assume an Engine Room spans two decks: the Hold (with a height of 3') and the Platform Deck (with a height of 8'), for a combined height of 11'. The Engine Room contains a fuel tank with the same height as the Hold (3'). The fuel tank should NOT be considered a reduced-height compartment because it is the same height as the Engine Room is <u>on that level</u>.

Review the available drawings and determine which compartments are of reduced-height and in which compartments they are enclosed. Record the Plan IDs of any reduced-height compartments, the approximate height of those compartments, and the Plan IDs of the enclosing compartments on worksheet part 7.

E. CREATING S-LAYERS

Before the coordinates of all bulkheads for each compartment can be sent from SHIP.DWG to the database, the drawing must be a simple representation with polylines on the drawing representing compartments, and two compartments that share the same bulkhead must have the same vertex coordinates for that bulkhead. The method devised to accomplish this is not elegant, but if done carefully, will achieve the desired accuracy.

Read through this entire section before beginning. If no AutoCAD drawing files of the Deck Plans exist at this point (and Section B was followed), the procedure for creating s-layers is slightly different than if AutoCAD drawings were used to create deck plans which were inserted into SHIP.DWG (Section C). When the procedure differs, there will be a bold statement introducing to each technique (**"From Paper Plans:"** or **"From AutoCAD Drawings:"**) so that the user may select the appropriate instructions. When the procedures are the same, there will again be a bold statement **"Both Procedures:"**.

There is a series of s-layers ("simplified" layers) labeled s-1 through s-9 in the SHIP.DWG. Each s-layer corresponds to a deck layer. All compartments, including compartments created for modeling purposes (such as type III and IV ladders or subdivided passageways) will be drawn on the appropriate s-layer. First, using the **POINT** command, point markers will be placed to mark the vertices of each compartment on the appropriate s-layer. Then, the point markers for each compartment will be connected with a single closed polyline using the **OSNAP NODE** command. The point marker (**PDMODE, PDSIZE**) used for the **POINT** command is described in Appendix M. Figure III-8 shows correct and incorrect point marker placement.

The cross hairs of the point marker combined with the 0.2 foot **SNAP** setting in SHIP.DWG allow consistent positioning of points to ensure that a bulkhead is straight. If a point marker doesn't fall exactly on the compartment vertex because the snap setting won't allow it, it will be no more than 0.2 foot off in any direction. The important thing is that a straight bulkhead is drawn straight and that compartments sharing vertices are drawn with their polyline vertices **OSNAPped** to the same **NODEs** (point markers). It is also important that bulkheads which span more than one deck, such as watertight bulkheads or stair towers, are on the same plane on all decks where they occur. Accurate representation of the connections between compartments is the most important goal of this process.

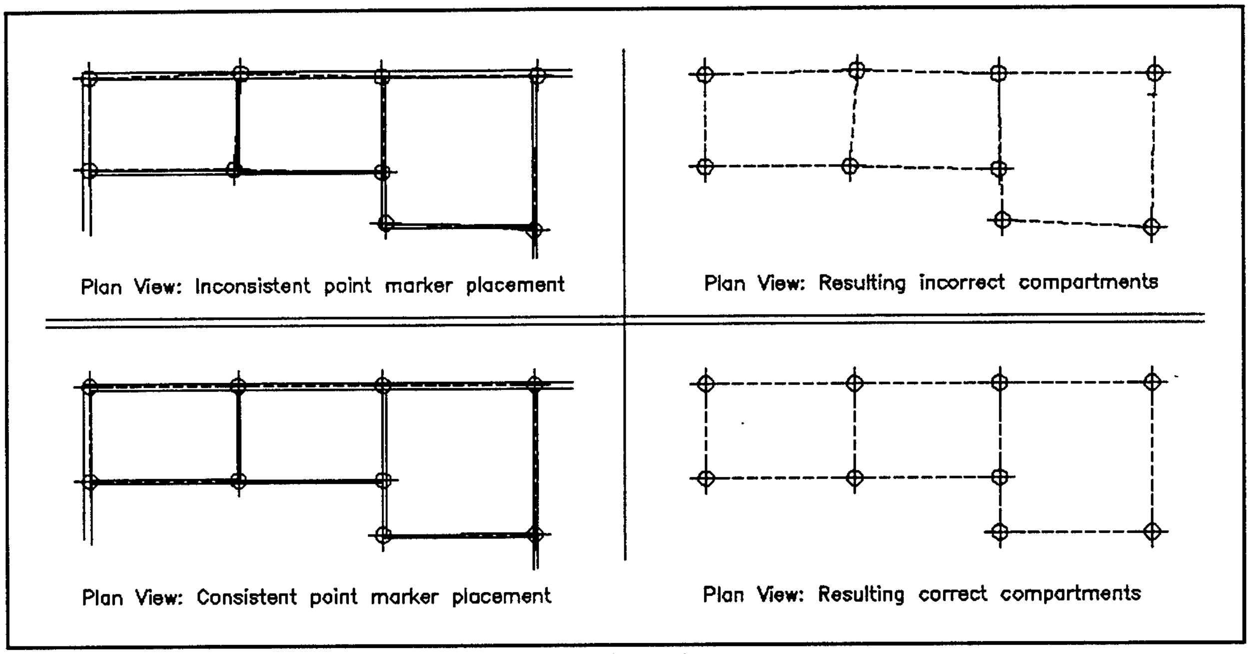


Figure III-8 Correct and Incorrect Point Marker Placement

E.1. Place the Point Markers

From Paper Plans:

- **SNAP** should be **ON** and set to 0.2.
- The **OSNAP** mode should be **NONE** (the default)
- **D1** layer s-1.
- Using the **POINT** command, place a point at each compartment's vertices, observing the POINT MARKER NOTES below. The coordinates may be entered into the **POINT** command from the keyboard or digitized from blueprints. PUT ONLY ONE POINT ON EACH VERTEX. The point should be the color of the s-1 layer, indicating that the s-1 layer is the current layer. "S-" layers are colored alternately red and green with odd numbered layers being red and even being green.

From AutoCAD Drawings: Each deck inserted from the working file will be "traced" in simpler form onto the corresponding s-layer by first placing point markers on the vertices of each compartment. Review the POINT MARKER NOTES below.

- **SNAP** should be **ON** and set to 0.2.

- The **OSNAP** mode should be **NONE** (the default)

- **D2** layers s-1 (current) and 1.

- **ZOOM** in on a portion of the deck, if necessary, starting at the bow.

- Using the **POINT** command, place a point at each compartment's vertices, observing the POINT MARKER NOTES below. PUT ONLY ONE POINT ON EACH VERTEX. The point should be placed as close as possible to the vertices from the layer 1 and should be the color of the s-1 layer, indicating that the s-1 layer is the current layer. "S-" layers are colored alternately red and green with layer s-1 being red and s-2 being green, etc.

Both Procedures: Point markers should be placed to mark class III and IV ladders as well. Refer to Appendix K for methods of drawing ladders.

POINT MARKER NOTES:

- It is helpful to use an inboard profile drawing of the ship to note which bulkheads span more than one deck. In particular, watertight bulkheads and stair towers often fall into this category. After layer s-1's points have been placed, record on the paper plans the x and/or y coordinate of the points which will be in common between s-1 and decks above it so that the same coordinates can be used when placing points for common bulkheads on all decks. If a profile doesn't exist, it may be helpful to sketch one after learning from the ship itself where these bulkheads spanning more than one deck are located.

- If a compartment has a curved bulkhead, approximate the curve with two or three point markers or ignore the curve if it is simply a rounded corner.

- Decks below the main usually have sloping hulls. Exterior compartments on these decks are narrower at the deck line than at the overhead line. To better approximate the volume of these compartments, place the point markers midway between the line of the deck and the line of the overhead. However, if straight interior bulkheads have been erected in front of these sloping bulkheads, place the point markers on this interior bulkhead. See Figure III-9 for an example of vertex placement and resulting compartments for a deck with a sloping hull and interior bulkheads.

- For compartments sharing a diagonal bulkhead, place the point marker of the adjoining compartment's vertex EXACTLY ON that shared diagonal bulkhead. It may be necessary to adjust the locations of these point markers once the polylines are drawn. Use **OSNAP** option **NEAR** when relocating the point markers to ensure the vertex is on the diagonal bulkhead. See Figure III-10.

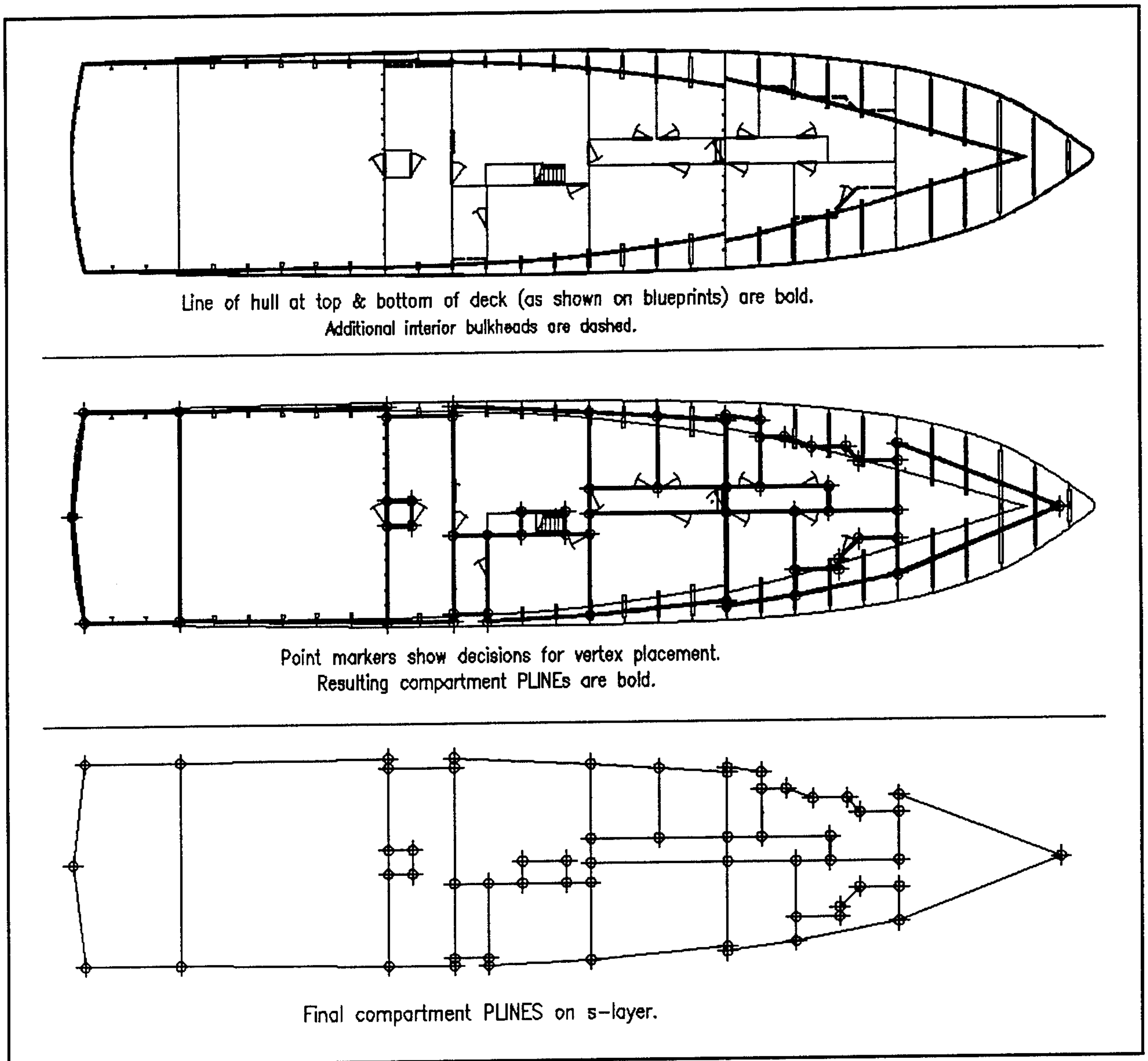


Figure III-9 Vertex Placement in a Sloping Hull

It may be difficult to determine the appropriate location for all point markers the first time through. Once the compartment polylines are drawn, adjustments may be made to the point markers and polylines until they meet the guidelines in this section.

E.2. Draw the Compartment Polylines

After all vertices of deck #1 are marked with points on the s-1 layer, set **OSNAP** to **NODE** so that each point marker can be easily picked. Connect the point markers around each compartment using the **PLINE** command, observing the POLYLINE NOTES below. Use the **CLOSE** option to complete each **PLINE** command. This ensures the compartment is completely closed. **CLOSE** one polyline before beginning the next. Since the **OSNAP** is set to **NODE**, the nearest point marker will be selected at each pick.

It helps to select the vertices for each compartment always in the same order. For example, always start in the lowest left hand corner of a compartment and move clockwise around the compartment. Employing such a pattern will prevent many errors. Be systematic in the order the compartments are selected for drawing so as not to miss or duplicate any compartment polylines. Check off each compartment on the plan view plots as its compartment polyline is completed. Be sure no compartment polylines, especially interior ones, are skipped.

POLYLINE NOTES:

- Review Section D.1.2 to determine which vertices define nested compartments, if any exist. If a compartment is not nested but is simply adjacent to another as defined in Section D.1.2, remember to draw them as shown in Figure III-3b through III-3d.

- Make sure that bulkheads perpendicular or parallel to the centerline are drawn exactly straight. The 0.2 foot SNAP will help. Toggling the **ORTHO** option **ON** (**<F8>**) will keep such bulkheads straight.

- When drawing a compartment that adjoins two or more compartments on one side, be sure to draw the polyline using only the vertices for the current compartment.

  EXCEPTION: **Do** pick the intermediate points along a bulkhead if it is a diagonal bulkhead with adjoining compartment vertices along it. This exception is very important for the calculation of correct barrier connectivity. See Figure III-10.

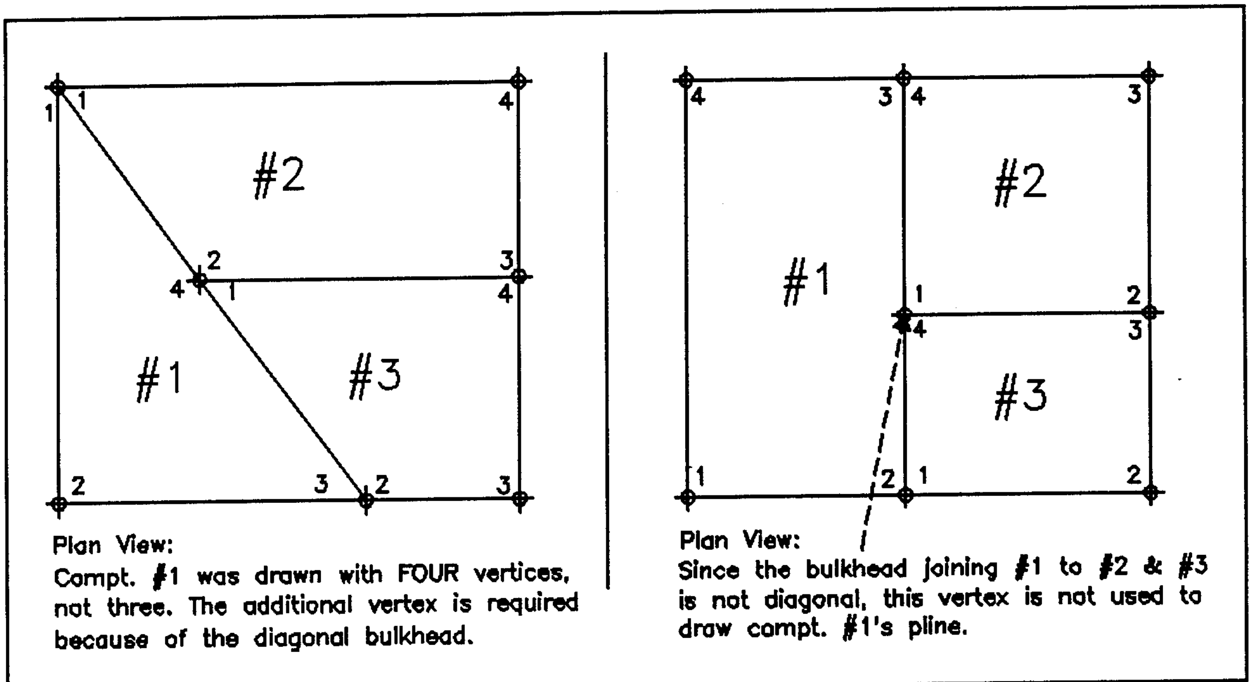


Figure III-10 Vertex Placement, Diagonal Bulkheads

E.3. Complete Compartment Text

Each compartment polyline needs to contain the following text: compartment name, Plan ID, and CUI. While it is not required that these text elements be in this order, it is less error prone when selecting them for dxf files to export the compartment data from AutoCAD to the database.

It is important that each line of text be sized to fit completely within the compartment polyline, without touching any other entities. Use the **SCALE** command when necessary to ensure each line of text is as large as possible yet small enough to allow it to be selected uniquely later on. The compartment text does not have to be completely legible when the entire deck is visible on the screen. A long compartment name (max length = 40 characters, including spaces) may be divided to be printed on up to four lines if necessary.

It is also important that the compartment name, plan ID, and CUI are not on the same line of text since they must be selected as individual components when the drawing information is exported from the drawing in Section G.

NOTE: All text in SHIP.DWG must be in UPPERCASE and not underlined.

From Paper Plans: Using the **TEXT** (or **DTEXT**) command, type the compartment name and Plan ID on separate lines and in UPPERCASE letters in each compartment. Compartment names that begin with a numeral, e.g. "8-Man Berthing", MUST have the numeral enclosed in parenthesis, e.g. "(8)-Man Berthing", to be recognized properly by SAFE. Size and place the text so it is completely contained within its compartment, not touching the compartment polyline or any other entity. There should be enough space between lines of text so each may be selected uniquely. Type the deck name below the deck outline near the bow.

From AutoCAD Drawings: When all compartment polylines for deck #1 are completed on the s-1 layer, issue the **CHANGE** command and select all deck names, compartment names, and Plan ID's on layer 1 and change their layer to s-1. The text should become the color of the s-1 layer. If the compartment names and ID's are underlined, the underline must be deleted. It is also helpful to **MOVE** the deck name to a position beneath the deck outline, as close to the outline as possible, near the bow. Using the **TEXT** command, add compartment text (name and Plan ID) to any type III or IV ladders and to any other compartments added for the analysis. All text must be separated enough from other entities so that it may be selected uniquely later on.

Both Procedures: Type the CUI's (UPPERCASE) from the plan view plots in each compartment under the compartment Plan ID.

DI layer s-2 and create the deck assigned #2 utilizing the instructions in Sections E.1.-E.3. Repeat for subsequent decks. The first points to be drawn on each subsequent s-layer should be the points which define bulkheads that span multiple decks as explained in the POINT MARKER NOTES at the end of Section E.1. Remember to set **OSNAP** mode to **NONE** (the default) and **SNAP** to **ON** and set to 0.2 when point markers are being placed. When compartment polylines are drawn set **OSNAP** to **NODE**. **SAVE** the drawing often.

When all compartment polylines are drawn, review each layer and make adjustments to the point markers and compartment polylines as required. Adjustments for vertical alignment of bulkheads on adjacent decks, particularly watertights, should be minimal and will be made in Section F.1. **END** the drawing when finished. Once all decks are drawn and labeled on the s-layers, this section is complete.

F. COMPLETE THE SHIP.DWG FILE

Once all decks are drawn onto their s-layers, SHIP.DWG should be in the ultimate drawing format regardless of how SHIP.DWG was created.

F.1. Reconcile Layer Discrepancies

After all decks have been created on or traced on their s-layers, it is time to align the compartment bulkheads that are supposed to be aligned vertically, such as watertight bulkheads on adjacent decks. Class IV ladder compartments (drawn as compartments on both upper and lower layers) should be aligned as illustrated in Appendix K, Figure K-6. If inter-deck alignment was handled carefully in Section E, this step should be just a verification, and should require little time.

D2 layers s-1 and s-2 and decide which polyline segments need to be shifted to line up vertically. Usually, a shift is no more than a few tenths of a foot. Figure III-11 displays a before and after comparison of the shift of a bulkhead. Note that the exterior bulkheads, if already correct, should not be aligned if the hull of the ship narrows as it approaches the keel.

NOTE: Bulkheads on adjacent decks that are to be aligned vertically MUST share the same X coordinate to TWO decimal places.

If a change needs to be made:

- Make the s-layer of the offending polyline the current layer (the new point markers and polylines should be the right color).
- Turn **SNAP ON** and move the point markers to be shifted and **ERASE** the corresponding polyline.
- Set **OSNAP** to **NODE** and draw the new polyline.
- Be sure to redraw any adjacent compartment polylines that are affected AT ALL by the shifting of the offending polyline and its point markers.

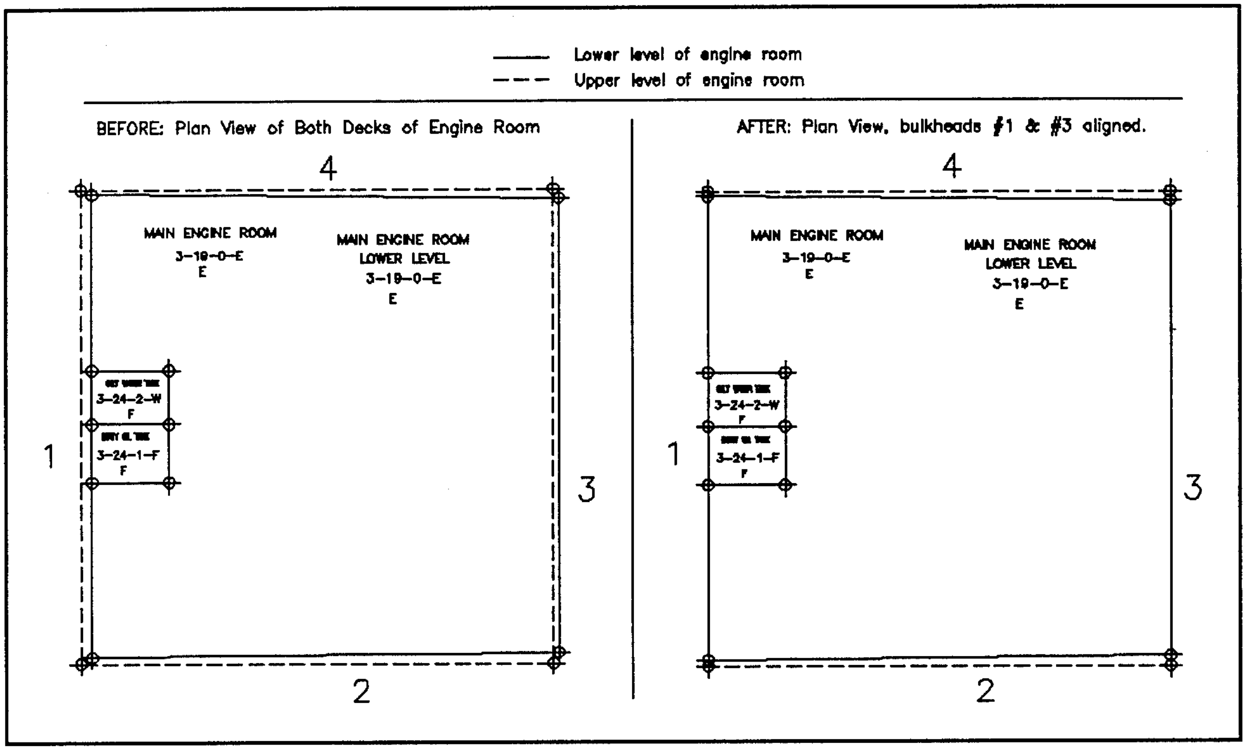


Figure III-11 Reconciling Bulkheads

Repeat the reconciliation for layers s-2 and s-3, s-3 and s-4, and so on up to the top two layers of the ship. It may take a few comparisons of s-layers to complete the reconciliation.

F.2. Mark Doors, Windows and Hatches

Door and hatch blocks and their insertion points are shown in Appendix M. These blocks merely mark the bulkheads or overheads that will need doors, windows or hatches entered into them during the tailoring of bulkheads and overheads in Chapter IV. The actual placement of a block on a bulkhead or overhead is not critical, as long as it connects the correct two compartments.

MARK DOORS and WINDOWS:
D1 to layer s-1. Set **OSNAP** to **NONE**, then mark door and window locations on the compartment polylines by **INSERT**ing the block named **DOOR** on the bulkheads with doors or windows, rotating the block so the door lies along the bulkhead.

Be sure to **INSERT** a door block on bulkheads with open doorways as well. This includes class III and IV ladder compartments with an open doorway.

Repeat for all s-layers.

MARK HATCHES:
Set **OSNAP** to **NONE**, then **D3** to display 3 layers. If the hatch to be entered connects layers s-1 and s-2, display layer o-1, s-1, and s-2. o-1 (not 0-1) stands for "o"verhead of layer s-1. The first layer to follow the command **D3** should be o-1 so that o-1 will be the current layer. Mark hatch locations on the o-layer by **INSERT**ing the block named **HATCH** on the drawing, ensuring that the hatch is placed so that it connects the correct two compartments. If the o-layer is current, the hatch will appear in white, not in the s-layer color of red or green.

Be sure to **INSERT** a hatch block on overheads with open hatchways. This includes class II and III ladder compartments with open hatchways. Also enter hatches in weather overheads but use **D2** rather than **D3** to display that o-layer and its corresponding s-layer. (The o-layer should always be listed first so that it is set to the current layer.)

Repeat for all s-layers and the corresponding o-layers.

Compartments without openings will be flagged by the database so be sure all door and hatch locations are marked on SHIP.DWG. **SAVE** the file upon completion.

Especially if the only other general arrangement deck plans were hand-drawn paper plans, it will be helpful at this point to plot the s-layers, one layer per page, at the same scale. To do this, D1 to the largest deck and ZOOM EXTENTS. Plot the display, then D1 to the other decks in turn and plot the display without changing the ZOOM setting. These plots will be useful in the next section when elevation and thickness are assigned, when doors, windows and hatches are entered in AutoCAD barrier blocks in Chapter IV, and for general reference during the analysis.

F.3. Add Elevation and Thickness to Compartment Polylines

Before adding elevation and thickness to each compartment, use the SAFE utility **COUNTCOMPS** to make sure that there is one, and only one, compartment polyline drawn for each compartment name, Plan ID and CUI grouping on each layer and that the number of compartment polylines drawn on each s-layer equals the number of Total Compartment Polylines for each deck on the AutoCAD worksheet part 4.

To use the **COUNTCOMPS** utility:

- **D1** to layer s-1.
- Issue the **COUNTCOMPS** command which will zoom to the layer's extents and display the total number of compartment polylines on the layer:

  Number of polylines on this layer: XX

  This number (XX) should be compared with the corresponding compartment count on AutoCAD worksheet part 4. Then the user will be asked:

  Want to see the polylines highlighted in DXFLayer order? Enter Y or N

  If "Y" is entered, the compartment polylines will be highlighted white, one at a time, and assigned a number: **Compartment X**

  If the total number of compartments corresponds to the compartment count from the AutoCAD worksheet, record each compartment's number inside the compartment's polyline on the paper plots. This information may be very helpful when creating coordinate (.DXF) files in Section G or if there is a difference between the total number of compartment polylines listed on the worksheet and displayed on the screen. This sequential highlighting of compartments may make it easier to see where there may be a polyline that was missed or where a duplicate was drawn. **COUNTCOMPS** may be repeated as many times as necessary to get a correct compartment count and a correct sequential numbering of polylines on the paper plans.
- Repeat for all s-layers.

Now that the compartment polylines have been reviewed, elevation and thickness of each segment determined in Section D.4 may be added to the polylines. For AutoCAD Release 12, this will be done using the SAFE utility **SETZ** to assign an overall default elevation and thickness to each layer and the **CHANGE** command to make exceptions to the overall default. For AutoCAD Release 11, the **MOVE** command will be used in an alternate, pre-defined **UCS**. Both procedures are discussed below. The **VPORTS** configuration named **BOTH** is available in SHIP.DWG regardless of the AutoCAD version.

NOTES (both procedures):

- A pre-set viewport configuration named **BOTH** displays the plan view and profile view of the drawing simultaneously. All changes, however, should be made on the plan view.
- Don't change the elevation or thickness of compartment text or point markers. All text and point markers should remain at elevation and thickness of zero.
- After the default layer or segment's elevation and thickness are added, any reduced-height compartments that exist should have their thickness adjusted to represent their correct height.

RELEASE 11:

Elevation can not be edited via the **CHANGE** command. The alternative procedure is as follows:

- Turn **UCSICON ON**
- **D1** to layer s-1, **ZOOM WINDOW** around first segment (whole deck if manageable).
- Set **UCS** to **FRONT**, but set **PLAN** to **WORLD** (broken pencil UCS icon)
- **MOVE** polylines in first segment to desired elevation:

  MOVE: (select polylines) **BASE: 0,0 SECOND PT: @(new elev)<90.**
- Repeat for all segments on that layer.
- Set **UCS** and **PLAN** to **WORLD**, then **CHANGE THICKNESS** of polylines in each segment, including reduced-height compartments.
- Repeat for all s-layers.
- When through, **VPORTS RESTORE BOTH** to view plan and profile.
- Click on the bottom window (profile view) to make it active and verify all polylines have been elevated and "thickened" by **LIST CROSSING** across each layer, noting the number of items selected, then cancelling the **LIST** with **<ctrl-c>**. Compare the number of items selected with the number of polylines on the s-layer (from the plan view - top window). If fewer items were found on the profile view, check each polyline on the plan view with the **LIST** command until the polylines without thickness and/or elevation are found. Correct these with the appropriate method from above.

RELEASE 12:

- **D1** to layer s-1.
- Issue the **SETZ** command which will zoom to the layer's extents and display the plan view in the top window and the profile view in the bottom. The program will display:

  Enter default deck elevation (in feet) above 0.0 feet:

  The user should enter the predominant deck elevation for this layer. Remember that elevation is cumulative from the bottom deck upward, with the bottom deck's lowest elevation being 0.0. Then the program will display:

  Enter default compartment height (in feet) above the deck:

  The user should enter the predominant compartment height for this layer. This height is not cumulative, but is the height above the deck elevation just entered that represents most compartments on this deck. The program will proceed to set the elevation and height of all compartments on the deck to the settings supplied. Watch the profile view as the compartments assume their assigned elevation and thickness. The procedure may be repeated if an error in either elevation or height is noted.
- If there are exceptions to this default, either for a stepped deck segment or for individual reduced-height compartments, click the pointing device in the top window to make the plan view active. Use **VPORTS SINGLE** to return to world view. Issue the **CHANGE** command, select compartment polylines with the exceptions to the default elevation and thickness, then select **PROPERTY** and enter the **ELEVATION** and **THICKNESS** for those compartments.
- Repeat for all s-layers.
- When finished, view all layers by using the SAFE utility **DS** to display all s-layers. Issue the **VPORTS** command, then select **RESTORE** and enter BOTH. Click on the bottom window and **ZOOM ALL** if necessary to see the entire drawing. When satisfied that elevations and thicknesses are correct, click on the plan view window, then **VPORTS SINGLE** to return to world view. **SAVE** the drawing when finished.

G. CREATE COORDINATE (.DXF) FILES

Now that the SHIP.DWG file is in the ultimate format and complete, the coordinate files may be created for loading compartments and barriers into the database.

DXF NOTES:

- Door and hatch blocks ARE NOT included in the .dxf files.
- Skip any polylines on the s-layer that are NOT compartment polylines by entering **N** at the **DXFOUT THIS PLINE?** prompt. They will then be displayed in yellow.
- Prompts will be repeated until an entity is selected. The routine cannot, however, determine if the CORRECT entity is selected. If a mistake is made, such as selecting the Plan ID for the second line of compartment name text, finish following the prompts for the compartment, then enter **N** at the **IS THIS COMPT. CORRECT?:** prompt. The compartment may then be redone.
- **'ZOOM** (transparent) may be executed while any prompt is displayed.
- Polylines will be displayed and prompted for (**DXFOUT THIS PLINE?**, step 2) in the order they were created in the drawing, which may not be from bow to stern of the deck. If the current view is a small portion of the deck, and the next polyline displayed in white is outside the current view, use **'ZOOM** (transparent) to view the entire deck to find the polyline currently prompted for. If it is still difficult to spot the polyline displayed in white, note the numbering of the compartments on the paper plan view plots done with the **COUNTCOMPS** command in Section F.3. Compartments are selected for **DXFLAYER** in the same order.
- When **'ZOOMing** around the s-layer, the white polyline of an interior compartment may be obscured by other polylines when the screen is redrawn, making it difficult to determine which compartment is being prompted for. To re-display the white polyline, finish the prompts for the compartment by selecting any nearby entities, then enter **N** at the **IS THIS COMPT. CORRECT?** prompt. The entire polyline will be re-displayed in white, and the compartment may then be redone.
- If a selection error is noted in a compartment already completed, use CTRL-C to skip the rest of the polylines on the s-layer and start the **DXFLAYER** routine over. If the error involves a mistake in a polyline, fix the polyline before re-issuing the command.
- If the entire sequence FOR THE WHOLE S-LAYER is not correct, the **DXFLAYER** command can be issued again and the new file will replace the old.

CHAPTER III

The **DXFOUT** process will be implemented by the SAFE routine **DXFLAYER** (described in Appendix M). The **DXFLAYER** utility uses the **DXFOUT** command to create a standard .dxf file for an s-layer, containing compartment polyline coordinates and compartment text which will be loaded into the database. The **DXFLAYER** command creates a new .dxf file each time it is issued, automatically naming the .dxf file by the deck/layer number. The **DXFLAYER** routine cannot be stopped in the middle of an s-layer, so an s-layer must be completed in one session. Be sure there is time to complete an entire s-layer before beginning the **DXFLAYER** routine. Allow an hour the first time to include time for reading this documentation. It is easy to make a mistake during this process, but it is also easy to start over.

The **'ZOOM** and **'PAN** commands (transparent zoom and pan) with the **DYNAMIC**, **WINDOW**, and **PREVIOUS** options should be used to move around the deck from within the **DXFLAYER** command. The routine will automatically **ZOOM EXTENTS** before the entity selection process begins.

TO BEGIN:

Enter SAFE and choose "Prepare AutoCAD Drawing" from the SAFE Main Menu.
D1 to layer s-1, then issue the **DXFLAYER** command.
After the **ZOOM EXTENTS** is finished, the routine will display the message
READY TO DXFOUT LAYER S-1, then prompt for the following items:

1. **SELECT DECK NAME:** Select the deck name text.
   The first polyline will be displayed in white.
2. **DXFOUT THIS PLINE? (Y or N):**
   If **N** is entered, the polyline, now skipped, is displayed in yellow, the next polyline is displayed in white, and the step is repeated for this next polyline.
   If **Y** is entered, up to four lines of compartment name text are prompted for as follows:
   a. **SELECT COMPT. NAME #1:** Select the first line compartment name text.
   b. **SELECT COMPT. NAME #2, RE-SELECT #1 TO SKIP:** If the compartment name is only one line of text, select it again to signal that there are no more lines of compartment name text.

If the item selected for compartment name #2 is not the same item as selected for compartment name #1, the next prompt is:

b*. **SELECT COMPT. NAME #3, RE-SELECT #2 TO SKIP:** If the compartment name is only two lines, select the second line again to signal that there are no more lines of compartment name text.

If the item selected for compartment name #3 is not the same item as selected for compartment name #2, the next prompt is:

b**. **SELECT COMPT. NAME #4, RE-SELECT #3 TO SKIP:** If the compartment name has only three lines, select the third line again to signal that there are no more lines of compartment name text.

When all compartment name text is selected, whether one, two, three, or four lines, the next prompts are:

c. **SELECT Plan ID:** Select the compartment's Plan ID text.

d. **SELECT CUI:** Select the compartment's CUI text.

All components of the compartment -- the polyline, name (up to four lines), Plan ID, and CUI should appear "selected" (dashed lines).

3. **IS THIS COMPT. CORRECT? (Y or N):** If N, all selected items are un-selected, the same polyline is re-displayed in white, and the routine returns to step 2 to allow the same compartment to be redone.

   If Y, the message **WRITING COMPARTMENT...** appears, all selected items are **DXFOUT**ed, and the next polyline is displayed in white. The routine continues with step 2.

When the routine is complete for the entire s-layer, all polylines should appear briefly as either yellow (skipped) or "selected" white (written). All compartment text (names, Plan ID's, CUI's) will appear as "selected" if written, or normal if inside a skipped polyline. The **DXFOUT** file will be closed, and all entities will be returned to their original color automatically.

D1 the next s-layer and issue the **DXFLAYER** command. Repeat for all s-layers.

When the **DXFLAYER** routine has been completed for all s-layers, **END** the drawing and exit AutoCAD to return to the SAFE Main Menu.

Chapter IV. LOAD DATABASE WITH SHIP DATA

This option appears on the "SAFE Main Menu".

A. CHAPTER OVERVIEW

This chapter describes the process of loading the database via AutoCAD, database entry screens, and the SAFE menu with all the coordinates and values it needs to run the probabilistic model on this ship. General ship information will be entered through a database screen, then the ".DXF" files created in Chapter III will be loaded and used to calculate the ship geometry.

Once the ship geometry is complete, a careful review and adjustment of Plan IDs and CUIs is made. Then the recommended ship visit (Section I.C.3) must be conducted. When all ship visit forms are completed, fire parameter values for each compartment and material values for each barrier must be assigned.

For compartments, the user has the option of:

	1.	assigning the SAFE default values which were chosen for each CUI by SAFE's developers;
AND/OR	2.	assigning/adjusting default values by CUI;
AND/OR	3.	assigning/adjusting values individually for each compartment.

For barriers, the user:

	1.	must assign default materials for all barrier types and an overall thermal and durability derating for the ship;
THEN	2.	may adjust default interior bulkhead and overhead materials by CUI;
AND/OR	3.	may adjust interior overhead materials for individual compartments;
THEN	4.	must enter doors and hatches and may tailor material values in AutoCAD. The barrier values will be read as AutoCAD attributes into each barrier of SHIP.DWG. The tailoring of these values allows for deviations of individual barriers to be entered. Doors are also entered into their bulkheads and hatches into their overheads during tailoring. The tailored barrier values are then used to update the database.

When tailoring is finished, all data necessary to calculate Full Room Involvement Time (FRI) will have been entered and FRI time and post-FRI heat release rates for each compartment and for each damage control condition (XRAY, YOKE, and ZEBRA) may be calculated. The results of these calculations can be viewed for all compartments considered in the simulation, and the FRI time may be adjusted for compartments where the calculated FRI time seems unreasonable to the user. Reviewing A (probability of Automated Suppression) and M (probability of Manual Suppression) values for each compartment in light of the FRI times that have been established concludes the process and completes the chapter.

When the loading of the database is complete, the database is ready to run the probabilistic model, documented in Chapter V.

Reports of values assigned can be obtained at various places through the SAFE menu system.

B. COMPLETE/UPDATE SHIP/DECK INFORMATION...

This option appears on the "Load Database with Ship Data" menu.

B.1. View/Print Values Assigned

A report of current ship/deck information may be viewed/printed.

B.2. Modify Values

When this option is selected, a screen will appear allowing reviewing and/or modifying of some of the basic ship and deck information entered when "Enter a New Ship" was selected (See Section II.C.)

C. ENTER COMPARTMENT/BARRIER DATA...

This option appears on the "Load Database with Ship Data" menu.

This section handles the loading of the remainder of the database. The ".DXF" files are tested, the ship's geometry is created and loaded; the discrete fire parameter values are assigned to each compartment and barrier by the user.

This section is divided into five steps:

C.1. Create Ship's Geometry;

C.2. Review/Change Plan IDs, Names or CUIs -- This may be done until the probabilistic model is run, but must be done with care;

C.3. Prepare for Ship Visit -- Ship visit forms may be generated after the first step is completed;

C.4. Assign & Tailor Compartment Values;

C.5. Assign & Tailor Barrier Values.

To alter the ship's geometry in SHIP.DWG after the last step requires this entire section to be repeated, beginning with new ".DXF" files.

Select option a. from the "Enter Compartment/Barrier Data..." menu to begin creating the ship's geometry.

C.1. Create Ship's Geometry...

This option appears on the "Enter Compartment/Barrier Data" menu.

Read this entire section, through Section C.1.3, before continuing. If the ".DXF" files were created in Chapter III, processing will automatically begin as described below in Section C.1.1 (Process "DXF's") when this option is selected.

This section contains most of the procedure used to create the ship's geometry. It requires the user to examine and correct SHIP.DWG until the information it contains generates the geometry that correctly models the ship. If this section is exited before all steps are completed, the process may be continued from the point at which it was left by selecting this option upon re-entry.

This option is divided into three main sections:

C.1.1. Process ".DXF's"

C.1.2. Create/Verify Barriers

C.1.3. Geometry Correct: Load Database

These three sections have corresponding menu options allowing the user to enter and exit the process freely. The "Process .DXF's" and "Create/Verify Barriers" sections are to be repeated until the information processed from the ".DXF's" contains no errors or omissions, then the "Geometry Correct: Load Database" section may be done.

C.1.1. Process ".DXF's"

The ".DXF" files created in Section III.G contain compartment names, plan ID's, CUI's, elevations, heights, and coordinates. The files are processed one by one in numerical order by deck number. On-screen messages indicate the status of the checking process of each ".DXF" file.

If duplicate plan ID's are found, the user will be asked if the duplicates are valid. Duplicates on the same layer, or on different layers, are acceptable ONLY IF they are separate portions of the same compartment. If on the same layer, such as the Auxiliary Machinery Space in Figure III-3b, the compartment portions may appear separate on the plan view, but three-dimensionally they must actually be connected. In the case of Figure III-3b, the tanks which separate the portions of the Auxiliary Machinery Space are only as high as the layer on which they are drawn, but the Auxiliary Machinery Space spans the tanks on the next layer. When barriers are created, the various portions of this compartment will be combined into one compartment.

Duplicate plan ID's on different layers are valid if a compartment spans more than one deck. For example, an Engine Room that spans two decks will have been drawn on both decks, so will be considered a valid duplicate.

Different compartments with different names must have different plan ID's. If different compartments have been given the same Plan ID, they are considered invalid and must be corrected in SHIP.DWG and "reDXFed".

When all available ".DXF" files have been processed, the "Review Processed DXF's" menu will appear offering reports for viewing or printing:

- Error Report: This is available only if errors exist. Most errors affect individual compartments in isolation and those compartments with errors WILL BE SKIPPED.
  For all, a corrected ".DXF" file for the affected layer(s) must be created and reprocessed.
  Common errors and their remedies are:
  - A compartment polyline has been drawn twice and selected twice during the **DXFLAYER** routine--the extra polyline must be erased.
  - A compartment name that begins with a numeral is misread as a plan ID--enclose the numeral in parenthesis.

- The ship has more than 450 compartments. At this stage of processing, one compartment which spans more than one deck (as the Engine Room cited in the introduction to this section) is considered to be a separate compartment on each deck where it is drawn. If there are more than 450 compartments, SAFE will not be able to analyze the ship.

♦ Status Report: This indicates which layers have had ".DXF" files processed during this iteration and which layers are ready for loading into the database. Before the database can be loaded, ALL layers must have had a ".DXF" file processed (Section C.1.3).

♦ Compartment Report: Lists information for all complete compartments that were found in the selected ".DXF" file(s). This report should be checked carefully, particularly the total number of compartments loaded on each layer and the elevation and height of each compartment. It may be wise to print this report, especially on layers that were processed with errors. The printed copy may be helpful in determining later whether the compartments in corrected partial ".DXF" files are replacements for, or additions to, compartments already processed. (See below "Make new .DXF files in AutoCAD".)

As discussed in the remainder of this section, this menu also offers the option to return to AutoCAD to make changes to SHIP.DWG and create new ".DXF" files, which will be processed as above. This cycle should be repeated until no errors are found and the list of processed compartments is complete. When satisfied, the user may proceed to "Create/Verify Barriers" by selecting "DONE: Continue with CREATE/VERIFY". Selecting "Return to Previous Menu" or "Xit SAFE" exits the "Create Ship's Geometry" section, but it must be re-entered to complete the process where it was halted.

Make new ".DXF" files in AutoCAD: Selecting this option will enter SHIP.DWG in AutoCAD. Make corrections indicated in the error file, along with any additions or changes to the compartment polylines and/or text. Most corrections involve items skipped during the **DXFLAYER** routine or text typing errors, but some involve incorrect compartment polylines, such as an interior compartment polyline that was never drawn, or drawn twice and selected twice during the **DXFLAYER** routine. Remember to correct and include these altered compartments as well as the compartments with skipped text items when creating the new ".DXF" files. If a compartment pline must be redrawn, MAKE SURE TO SET ITS ELEVATION AND THICKNESS again as described in Section III.F.3.

Once all polyline/text errors are corrected, new ".DXF" files must be created for reloading. There are two options for creating the new ".DXF" files. The **DXFLAYER** command may be used for:

i. An entire layer, or
ii. A "partial .DXF" of selected compartments on an s-layer. This is done be using the **DXFLAYER** command and skipping compartments already loaded correctly.

NOTE: When partial ".DXF" files are processed, there will be a distinction between partial ".DXF's" that contain compartments to REPLACE processed compartments and partial .DXF's that contain only compartments to be ADDED to the list of processed compartments. The latter implies that ALL compartments in the partial ".DXF" file were incorrectly processed and did NOT appear on the compartment report for that layer. The former may contain both additions and replacements. If a partial ".DXF" is created, be sure to note which type of partial file it is, referring to the printed compartment report to see if the corrected compartments appear on the list as "processed" compartments.

The choice of i. or ii. depends on the severity of the errors. If an s-layer had many errors or a change in a polyline affected several compartments, it might be easier to **DXFLAYER** the entire s-layer. If only one or two compartments on an s-layer require correction, only those compartments must be selected during the **DXFLAYER** routine, and the other compartments may be skipped. The new ".DXF" file created for that s-layer will contain only those compartments. If the choice is not obvious, or if it is not clear which compartments have been processed correctly and which have not, **DXFLAYER** the entire s-layer. Complete layer ".DXF" files are saved and may be reused if the entire geometry must be redone after the database is loaded. Partial layer ".DXF" files are not reusable. (See Section C.1.3). Regardless of the number of corrections per s-layer, there still will be ONE AND ONLY ONE ".DXF" file at a time for each s-layer. S-layers with no errors DO NOT need to be **DXFLAYER**-ed again.

Using the **DXFLAYER** routine, create the appropriate ".DXF" files, one for each affected s-layer. Refer to Section III.G for documentation. Remember to use the paper plots of each s-layer which have had compartments numbered using the **COUNTCOMPS** command described in Section III.F.3. Read the DXF NOTES below before beginning.

DXF NOTES:

- If the entire deck is being replaced, do not skip any compartment polylines.

- Whether a partial or complete layer ".DXF" file, ensure each compartment is complete. Correct compartment elevation and height (thickness) as described in Section III.F.3. Select ALL of the compartment text: entire name, plan ID, and CUI.

- For a partial REPLACEMENT .DXF file, the processing routine will prompt for which compartments that were already processed are being replaced by each partial ".DXF" file. Using the printed compartment report, mark which compartments in each ".DXF" file are replacement compartments because they exist on the compartment report. Any which are not on the compartment report for that layer are additions.

END the drawing and exit AutoCAD when all new ".DXF" files have been created.

IF ".DXF" FILES WERE CREATED WHILE IN AUTOCAD. . .

The ".DXF" files are automatically processed when AutoCAD is exited. Refer to this section for instructions. The "Process DXF's" cycle can be repeated until all compartments are correct, whereupon the "Create/Verify Barriers" and "Load Database" section must be done.

If the layer represented by the ".DXF" file being processed has been loaded before, a menu displaying replacement options will appear:

- **Replace Entire Layer Completely**: Select this option ONLY IF the ".DXF" file being processed contains the ENTIRE s-layer.

- **Delete Selected Compartments on Layer before Adding New Ones**: Select this option if processing a partial ".DXF" file containing replacement compartments, even if the file also includes new compartments to be added. The compartments to be replaced must be deleted from the current list of processed compartments before those in the partial ".DXF" file can be added to the list. Compartments may also be deleted, if necessary, even if there are no replacements in the ".DXF" file being processed.

Since compartments are referenced by a compartment number in this procedure, a listing of the current compartments and their compartment numbers may be viewed or printed (using the DOS PRINT SCRN key). When prompted, enter the compartment numbers of the compartments to be deleted/replaced, followed by **<enter>**. Conclude the list by pressing another **<enter>**. The compartments whose numbers were entered will be deleted from the list of compartments and the compartments in the partial ".DXF" file will be processed either to take the place of the deleted compartments or to be added to the list of compartments for this layer.

- **Only Add New Compartments from this ".DXF" file to the Layer:** Select if processing a partial ".DXF" file containing ONLY new compartments to be added (compartments that have not been correctly processed.) No prompts will be given. If the file contains compartments that were already processed, the compartments will be flagged as duplicates and should not be accepted.

- **Ignore this "DXF": Delete it and continue.**

These replacement options are re-displayed for each new ".DXF" file. After the replacement option for one ".DXF" file is selected, the file is tested as before. Once again, after all new ".DXF" files are processed, the "Review Processed .DXF's" menu will appear.

Repeat this section until the list of loaded compartments represents the SHIP.DWG s-layers accurately and completely. When satisfied, choose "DONE: Continue with CREATE/VERIFY" from the "DXF Files Processed" menu to proceed to the next section.

C.1.2. Create/Verify Barriers

The information processed from the ".DXF" files will be used to calculate the ship's barriers, which will be verified in AutoCAD. If correct, the user should select watertight bulkheads while still in AutoCAD. This section is comprised of several stages:

C.1.2.1. Create barriers, including stepped decks, from ".DXF" data.
C.1.2.2. Verify barriers in AutoCAD.
C.1.2.3. Pick watertight bulkheads.

Unlike a polyline which defines one complete compartment, a barrier represents the discrete physical connection between two compartments, or a compartment and the ship's exterior. A particular segment of one compartment's polyline may connect it to several compartments; each of these connections will be represented by a different barrier. See barrier types below.

Figure IV-1 demonstrates the difference between the compartment polyline and the compartment's bulkhead barriers.

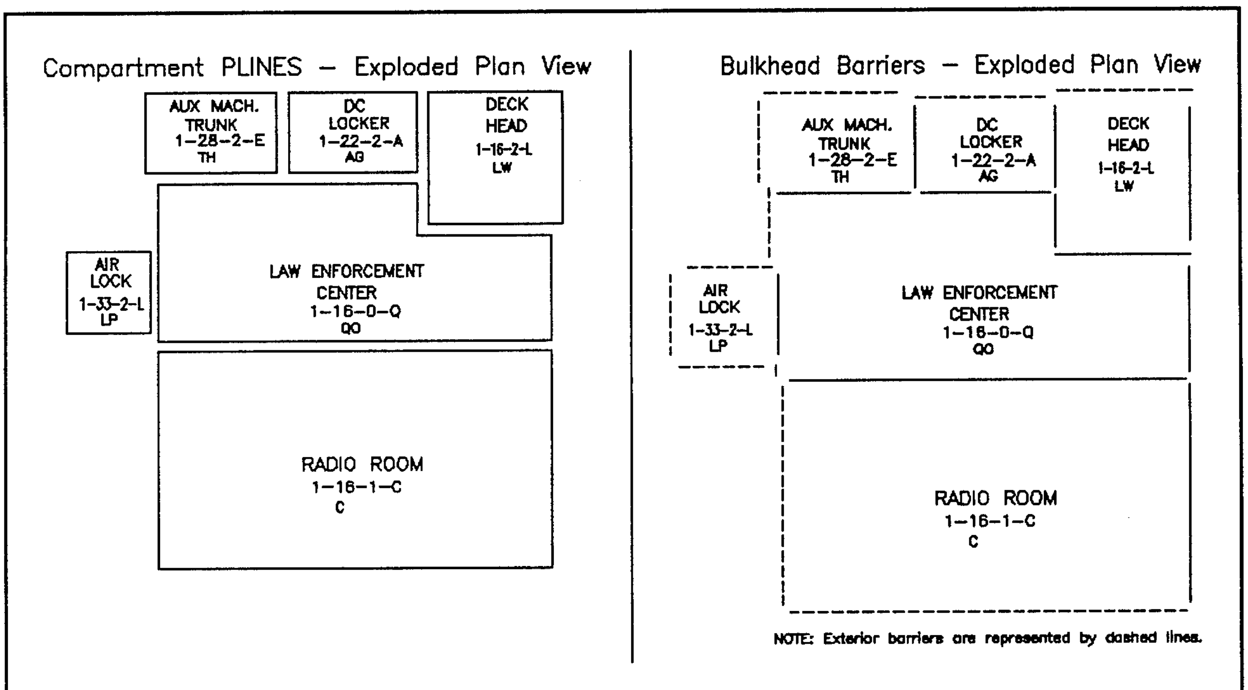


Figure IV-1 Compartment Polylines vs. Bulkhead Barriers

SAFE uses the following terminology to refer to barrier types:

Interior Bulkhead: Vertical connection between two compartments. "Stepped" indicates a vertical connection between compartments on two layers.

Exterior Bulkhead: Vertical connection between a compartment and the ship's exterior (hull or superstructure). "Stepped" indicates a vertical connection for a compartment with the exterior of the layer above.

Overhead: Horizontal connection between two compartments on different layers.

Weather Overhead: Horizontal connection between a compartment and the ship's exterior.

NOTE: When running the probabilistic model, SAFE does not consider the deck of the lowest layer of the ship because there is no connection between this deck and compartments below to generate potential fire paths and because fire travels predominantly upward or laterally, not downward. Primarily because of this, SAFE assigns parameters to horizontal barriers as the **overhead** of the lower compartment rather than as the deck of the upper.

Hatches are entered in the overhead of the lower of the two connecting compartments, not the deck of the upper. Barrier materials and strength derating are assigned to overheads.

When an assignment is made to a given compartment's overhead, the same assignment is reflected in the deck of the compartment above automatically. If a deck's steel or aluminum core is carpeted or tiled, this "overcoat" should be treated possibly as additional fuel load to the compartment (see Section C.3.3.4). This overcoat does not generally affect fire penetration downward through the deck because fire travels predominately upward or laterally. However, if a compartment's OVERHEAD is insulated, this should be noted by assigning an insulated barrier material to the compartment's overhead.

C.1.2.1. Create barriers, including stepped decks, from ".DXF" data.

This process first calculates the location and size of all barriers on the ship.

If a compartment is found with an elevation plus thickness that is less than the base elevation of the compartment above it and a thickness less than adjacent compartments of the same elevation, it is considered a possible **reduced-height** compartment.

Its layer number, plan ID, name and height (thickness) are displayed, and the user is asked to designate that this compartment:

a. is NOT of a reduced height. Correct in AutoCAD.
b. is of a reduced height and wholly enclosed in another.
c. has a valid height and is not enclosed in another.

a. is NOT of a reduced height.
SAFE will continue to request information about other potentially reduced-height compartments, but will require the user to correct the problem in AutoCAD and create a new ".DXF" file for the affected compartment(s).

b. is of a reduced height and wholly enclosed in another.
A list of adjacent compartments that are able to enclose it is given from which the user chooses the enclosing compartment and is prompted to verify the choice. Occasionally a reduced-height compartment will be partially enclosed in more than one compartment. For example, a water tank may be four feet in height and may stretch between two voids. Due to geometry calculation procedures, SAFE requires that only one of these compartments be selected as the enclosing compartment.

c. has a valid height and is not enclosed in another.
No further action is required. If a compartment has any weather overheads and has an adjacent compartment at the same elevation but with a greater thickness, SAFE cannot tell if it is enclosed in another compartment or not. If it is not, option c should be selected.

If compartments are found on the same layer with differing elevations, but there is no gap between these compartments and the compartments above them, "stepped deck" barriers are created.

C.1.2.2. Verify Bulkheads in AutoCAD.

When barrier calculations are complete, the user is prompted to **"Verify in AutoCAD"**.

The verification process discussed in this section is vital to running the probabilistic model. It is the final chance to catch errors in the ship's geometry before loading the database. Errors must be corrected or the ship's geometry in the database will not accurately reflect the actual ship. Common errors and methods to correct them are described below.

Only bulkheads are verified in this section. These bulkheads should match the locations of the compartment polylines on each s-layer. Overheads and weather overheads are not plotted since correct bulkheads allow correct overheads to be calculated. Once any inaccuracies in bulkheads are corrected, overheads are automatically corrected and need no verification.

When AutoCAD is entered, the bulkheads will begin to plot. On each b-layer, interior bulkheads are plotted first in yellow, then exterior bulkheads are plotted in purple. B-layers (barrier layers) are used by SAFE for verifying barriers and picking watertight bulkheads.

Verification is accomplished by examining a b-layer with a paper copy of its s-layer. The bulkheads should look identical to the compartment polylines as printed on the s-layer, with neither missing nor extra bulkheads.

Missing bulkheads indicate a type 1 error. Purple bulkheads inside the deck or yellow bulkheads on the exterior of the deck indicate a type 1, 2 or 3 error (see below), as do extra bulkheads not represented on the s-layers.

For each b-layer, verify the number of bulkheads plotted in any problem locations using the **LIST** command with the **CROSSING** option. This will give the number of items selected, and the **LIST** command can then be cancelled by **<ctrl-c>**. There should be only one bulkhead for each interior and external location. More than one indicates a type 2 or 3 error.

CHAPTER IV

ERROR TYPES:

There are three main types of errors which will cause incorrect plotting of the bulkheads:

Type 1:	Those caused by complete omission of a compartment from a ".DXF" file.
Type 2:	Those caused by mistakes in compartment representation, resulting in inaccurate ".DXF" files (Section III.C.1).
Type 3:	Those caused by incorrect polyline vertices (Section III.C.2) or by inaccurate point placement (Section III.E.4.1).

TO CORRECT ERRORS:

Type 1:	If the only errors are of type 1, missing compartments, create a new partial ".DXF" file for each affected s-layer in accordance with Section III.G.
Type 2:	If ANY type 2 errors are found, review Section III.C.1 and make corrections to each affected s-layer. Create new ".DXF" files for all affected layers in accordance with Section III.G. These ".DXF" files should include any missing compartments as well as corrected compartments.
Type 3:	Review Chapter III, Sections E.2 and E.2. The problem may be caused by a bulkhead which should be orthogonal (perpendicular) to the x or y axis but is not exactly so. (See Figure III-8.) Another possible cause is a diagonal bulkhead where intermediate points along the bulkhead were not picked when the polyline was drawn. (See Figure III-10.) In both cases the offending polylines should be erased and corrected, and a new ".DXF" file (either partial or complete) should be created.

END the drawing and exit AutoCAD when finished. If and when no errors are detected on the b-layers, watertight bulkheads may be selected before exiting AutoCAD. See "Pick watertight bulkheads" below.

IF ".DXF" FILES WERE CREATED WHILE IN AUTOCAD. . .

The option will be given to process them. Refer to Section C.1.1 for instructions. The "Process DXF's" cycle can be repeated until all compartments are correct, whereupon the "Create/Verify Barriers" section may be repeated.

C.1.2.3. Pick watertight bulkheads

Watertight bulkheads are selected to ensure that structural materials are assigned even though a non-structural facing may be assigned to each side of the bulkhead.

IF NO ".DXF" FILES WERE CREATED WHILE IN AUTOCAD. . .
Once the interior and exterior bulkheads are verified as accurate, the user should select the watertight bulkheads while still in AutoCAD. (If the user exits the drawing without entering this command, the program reminds the user that NO watertight bulkheads were chosen and offers the options of "a. Return to AutoCAD to choose them" or "b. OK: there are none on this ship.")

At the COMMAND: prompt **D1** to a **b-layer** where watertight bulkheads are to be selected. Enter **PICKWT**. The program will display:

> **Ready to pick yellow watertight bulkheads. If on a B-LAYER below the Main Deck, enter Y, otherwise enter N, change layers, and type "PICKWT."**

If the user types "Y", the program will '**zoom extents**'. Then, will display:

> **Select watertights. Purple exterior bulkheads selected will be ignored.**

The user then 'picks' each bulkhead section that is to be a watertight bulkhead. Each section becomes dotted as it is 'picked'. (If a section is mistakenly picked, press the 'cancel' button or CTRL-C and issue the **PICKWT** command again.) When through 'picking', press the **<enter>** key and the program will change the 'picked' bulkhead sections to blue and prompt.

> **This set of watertight bulkheads has been processed. Pick more watertights on this layer? (Y or N):**

If "Y" is entered, another set of bulkhead sections may now be 'picked'. If "N" is entered, the user may **D1** to another **b-layer** if watertights are to be selected there and issue the **PICKWT** command again. If "N" is entered, the bulkheads are also returned to yellow.

If errors are made in selecting bulkhead sections, enter **REDOWT**. The program will display:

> **ALL of the previously selected watertights on ALL layers have been DELETED.**

The process may now be redone on all b-layers.

END the drawing and exit AutoCAD when finished.

C.1.3. GEOMETRY CORRECT: Load Database

When satisfied that the geometry is correct and the watertight bulkheads have been chosen, the database is loaded by selecting this choice from the menu. The loading process, which is automatic, may take several minutes depending on the ship's size.
A blue screen with a 'Working...' message indicates loading is taking place. As the database is loaded, this message will move up, then off, the screen. No user input is required.

The program will automatically combine compartments with the same plan ID that span more than one deck. Bulkheads with a length less than 0.5 ft. and overheads with an area less than 2.0 ft.^{2} will be not be loaded in the database. This is done not only to eliminate fire paths from forming between two compartments which are only slightly connected, but also to reduce the burden of considering these small barriers for hatch and door entry, barrier material assignment, etc. Experience has shown that in more cases than not, these tiny connections between compartments are a result of slight inaccuracies in drawing of compartment polylines and do not actually represent a barrier between the compartments.

A screen with a "Working" message indicates database processing is taking place. As the database is loaded, this message will move up, then off, the screen. No user input is required.

When finished, a menu will appear:

"The Ship's Geometry has been completed
and loaded into the SAFE database.
To make further changes now,
the entire 'Create Ship's Geometry' section
must be redone, beginning with new DXF files."

a. View/Print Compartment List from database.
b. Redo the entire Geometry.
Return to Previous Menu

a. View/Print Compartment List from database.
This choice will give the user an updated list of the ship's compartments, ordered fore to aft by layer with the compartment's Plan ID, Name, Area, and CUI. Compartments spanning more than one level will have been combined into one compartment.

b. Redo the entire Geometry.

Changes to the **geometry** of the ship (its **compartment plines, pline elevation, or thickness**) at this point or beyond this point will require the entire "Create Ship's Geometry" menu to be repeated, beginning with complete ".DXF" files for all layers. However, the **Plan Id, compartment name or CUI** for any compartment may be changed after this point (see Section C.2).

If the option to redo geometry is selected, the database will be reinitialized and SAFE will be reset for beginning again. The user will be asked to re-enter the number of layers below the Main Deck (in case that information will change with the geometry changes to be made.) Then the user's task is to make the geometry changes in SHIP.DWG and re-DXF each layer in its entirety. In the event that this is necessary, exit SAFE and refer to Appendix N for guidance on how to avoid having to re-DXF layers which need no corrections.

Return to Previous Menu

This choice returns the user to the "Enter Compartment/Barrier Data" menu where the next step is to 'Review/Change Plan IDs, Names or CUIs'.

C.2. Review/Change Compartment Plan IDs, Names or CUIs...

This option appears on the "Enter Compartment/Barrier Data" menu.

Before printing the ship visit forms, particularly those for compartment data, the analyst should review compartment information to be sure that an incorrect Plan ID, name or CUI was not assigned. Again, after the ship visit is completed, another careful review of compartment CUIs should be made before any compartment or barrier values are assigned by CUI. Also, any incorrect Plan IDs noted during the ship visit should be corrected. After the probabilistic model is run, a compartment's Plan ID, CUI or name cannot be changed. Two reports are now offered to assist in the review:

C.2.1. View/Print Compartment List Ordered by Layer

This choice is especially useful in spotting any incorrect Plan IDs. The compartments are ordered fore to aft by layer. A compartment that spanned more than one level and, therefore, was represented on more than one layer on the ship.dwg, will have been combined into one compartment with the compartment information only printed on its lowest layer.

C.2.2. View/Print Compartment List Ordered by CUI

This choice is especially useful in spotting any incorrect CUIs. Each CUI used on this ship and its description is printed, followed by a list of compartment(s) of that CUI ordered fore to aft by layer.

Since the compartment data forms are printed in CUI order and the CUI is potentially used to assign many fire parameters, it is recommended that the CUI, especially, be carefully reviewed, and changed in Section C.2.3, if necessary. When the process of entering compartment and barrier values from the Ship Visit Forms into the database in Sections C.4 and C.5 begins, the compartment's CUI may still be changed, but doing so will require a careful examination of the compartment and its barriers in tailoring to ensure that any previous values assigned by CUI are updated to reflect the new CUI.

C.2.3. Change Compartment Plan IDs, Names or CUIs

When this option is selected, a screen will allow the changing of Plan IDs, Names or CUIs. Plan IDs must remain unique.

After the screen is exited and if net changes have been made, a report listing the changes is available to view/print, and the user is offered the option to enter AutoCAD to make the same changes on SHIP.DWG using the **DDEDIT** command. If a Plan ID has been changed and AutoCAD barrier blocks have been loaded (Section C.5.3), SAFE will automatically run the AutoCAD 'Updates' routine to change the Plan ID in all barrier blocks where it occurs.

NOTE: If compartment ship visit forms have not yet been filled in, it is recommended that a new set be printed after a change is made to a CUI or Plan ID. If a CUI is changed, compartments will be re-ordered on data entry screens by the new CUIs and in a DIFFERENT order from the original Ship Visit Forms. If a Plan ID is changed, the new plan ID on the data entry screen will be different from that printed on the original Ship Visit Forms. If ship visit forms are not reprinted after Plan ID or CUI changes are made, great care must be taken in transferring data from the forms to the screen.

C.3. Prepare for Ship Visit...

This option appears on the "Enter Compartment/Barrier Data" menu.

The recommended ship visit discussed in Section I.C.2 is to be undertaken at this point in the analysis to confirm the ship's geometry as modeled in SHIP.DWG and obtain detailed information on each compartment to complete the SAFE database. Refer to Section I.C.2 for a discussion of the goals for this visit. If the ship being analyzed is in the design phase, a similar ship should be visited.

Four types of ship visit forms will be used during and after the ship visit: Reference Data, Ship Data, Compartment Data, and Barrier Data plots. The Barrier Data plots consist of plan view plots of SHIP.DWG using the procedure discussed in Section C.3.4 below. The ship visit forms are printed from this menu, and are also available from the "Data Entry Worksheets and Forms" menu (via "View/Print Reports and Forms" menu).

C.3.1. Ship Visit Forms--Reference Data

These forms are assembled for quick reference when assigning values during the ship visit. They list the various assignments which may be made to the following parameters:

- **Barrier Materials** - All barrier materials choices provided by SAFE and their material IDs are listed by structural or non-structural type. While conducting the ship visit, structural barrier material IDs must be assigned to the hull, superstructure, weather overheads, and watertight bulkheads. For interior bulkheads and overheads, structural or non-structural materials may be assigned. If the actual barrier material used in the ship's construction does not appear on the list, either assign the closest type from the SAFE choices or consider adding the new material to the list of available choices. Refer to Appendix A for a listing of SAFE-provided materials and their properties. In order to add a new material, all the material's properties either must be known or must be derived by comparing the new material to the list of SAFE materials. In the *Theoretical Basis*, Section 6.3.4.2 on Barrier Failure Modes discusses a method for determining Tbar and Dbar curve assignments for new barrier materials, and Section C.5.1 of this chapter describes the process of adding new barrier materials to the SAFE database.

If adding a new material is being considered, assign it a material ID for use during the ship visit using the guidance in Section C.5.1, and write the new ID on the Reference Data form as either a structural for non-structural material. In that way, the new material's ID may be used to assign it during the ship visit. After returning from the ship visit, its properties may be prepared for entry in the SAFE database as described in Section C.5.1.

- **Opening Types** - All doors, hatches, and operable windows on the ship must be assigned a type by the user on the barrier data plots. Door and hatch types allowed in SAFE and their Damage Control (DC) ratings are listed on the Reference Data Forms. See Section C.3.4 for further discussion of opening type assignments. Damage Control ratings, also termed the material conditions of readiness, are described in *Theoretical Basis*, Section 2.1.2.

  In addition to "XRAY", "YOKE", and "ZEBRA", condition "modified YOKE" is also described. Since this condition is usually designated by a ship's commanding officer and is essentially the same as condition "XRAY", it is not an option in SAFE. To classify an opening as "modified YOKE", assign it "XRAY". Condition "WILLIAM" is considered "ZEBRA" in SAFE.

- **Fire Growth Models** - The fire growth model is assigned to allow SAFE to determine the compartment's maximum heat release rate (Qmax) and the fire growth rate (alpha) for use in calculating compartment time to Full Room Involvement (FRI). Appendix D of this manual lists the fire growth models and typical CUIs to which they apply. *Theoretical Basis*, Appendix C documents the procedure for assigning a fire growth model and the corresponding percentages of deck area and compartment height occupied by the fuel to each compartment.

- **Active Detection/Suppression System Types** - SAFE's available protection systems and their codes are listed.

C.3.2. Ship Visit Forms--Overall Ship Data

These forms allow recording of information for the entire ship's barriers including:

- **Overall Barrier Derating Factors** - Assuming that a well-constructed new ship would have an overall barrier derating factor of 0%, implying that all barriers are at full strength, assign a value between 0 and -30 to both Thermal strength and Durability strength which indicates the overall condition of the ship. These values will be applied to all barriers, bulkhead and overhead, interior and exterior on the ship. Individual barriers may have these values adjusted to account for a barrier that is other than the default. The allowable adjustment for individual barriers is between 0 and -99%. Record these adjustments to individual barriers on the barrier data plots.

- **Barrier Materials ID's** - This section records the default material ID for each type of barrier. Choose the predominant material ID from the Reference Data Forms to be the default. Valid ID's for each barrier type are as follows:

Exterior Superstructure Bulkheads	STRUCTURAL types only
Exterior Hull Bulkheads	STRUCTURAL types only
Exterior Overheads (in Superstructure or Hull)	STRUCTURAL types only
Watertight Bulkheads	STRUCTURAL types only
Interior Bulkheads	Any type listed
Interior Overheads	Any type listed

Ships with different exterior materials below the main deck for the hull and above the main deck for the superstructure may have a separate default assignment for each. This option is not available for interior barriers for the overall ship.

Once these Default Barrier Material ID's are entered into the computer after the ship visit, it will be possible for SAFE to assign a barrier material to each and every barrier on the ship. Exceptions to these defaults assignments should be noted either by filling out the lower half of this form (Optional Interior Barrier Material Assignments by CUI) or by recording individual exceptions on the barrier data plots or both.

- **Interior Barrier Material ID Assignments by CUI** - (Optional) Default interior barrier material assignments can be made in SAFE assuming that compartments of like function (with the same CUI) will be constructed with like barrier materials.

  On a larger ship, this assigning of barrier materials by CUI may be desirable. On a smaller ship, it may be more efficient to have the default interior bulkhead and overhead materials assigned to all interior barriers and note exceptions on the barrier data plots (Section C.3.4).

  If this form which assigns material by CUI is used, its values for any given CUI will overwrite the default interior bulkhead and overhead assignments made for the overall ship. Record the CUI's predominant interior material ID from the Reference Data Forms next to each CUI in the 'Blkhds' and 'Ovhds' columns. This may be done after the ship visit using the information gathered on the barrier data plots. CUI's with different interior materials below the main deck (in the hull) and above the main deck (in the superstructure) may have a separate default assignment for each. Use the left two columns for the hull and the right two columns for the superstructure. Deviations from these default assignments should be recorded on the barrier data plots.

C.3.3. Ship Visit Forms--Compartment Data

Overview:

Spreadsheet-style forms are used to gather compartment data:

FSO's, Frequency of EB, % Monitored; I Values; Vents; Fire Growth Models, Fuel Load; Detection/Fixed Suppression Systems; Manual Suppression Systems; A & M Values.

Only the compartments that are considered in the analysis are listed. They are listed in the same order on all forms: first by CUI and then, within each CUI, by deck from bottom to top and from fore to aft. A line drawn after each CUI facilitates the overlapping and lining up of the forms. The plan ID and compartment name (abbreviated in some cases) are also provided on all forms. Column headings list the data to be recorded in each column, with units if applicable. These forms may be printed all at once or individually, but the entire set will be needed either during or after the ship visit. These completed forms should be retained with other ship analysis documentation. The information requested on each of the forms is discussed below.

Where appropriate, the Ship Visit Forms list SAFE defaults by CUI for a parameter in parentheses on the same line as the CUI definition. If a compartment with a given CUI is so like the "default" compartment for that CUI, an experienced analyst may find that using the printed SAFE default for a parameter is desirable. For example, if the fuel load in a CO stateroom is much like a typical CO's stateroom (CUI of L1), the default cellulosic and plastic fuel load by psf listed is very acceptable, making it unnecessary to estimate the total weight of all plastics and cellulosics in each compartment.

If the ship being analyzed is very large, collecting information on each compartment may not be economically practical. Two options exist in this case:

1. Use the SAFE defaults listed where they are appropriate (see above).
2. If the SAFE defaults don't appear suitable for this ship, at the very least data should be gathered for one compartment of each CUI type. The compartment chosen to represent other compartments of the same CUI should be representative of most compartments with that CUI. It is important to note variations from the selected compartment on the form.

If possible, photograph and/or videotape all compartments to facilitate assigning values to a compartment's fire parameters when the ship visit is over. The film exposure number(s) may be recorded next to the compartment Plan ID on one of the ship visit forms.

C.3.3.1. FSO's, Frequency of EB, % Monitored Form

The **compartment height** is listed on this form and should be verified, ignoring any dropped or false ceilings. The values printed on the form were assigned in SHIP.DWG as compartment thickness in Section III.F.3. If a significant difference in compartment height exists, it should be noted on the form. If the compartment height difference noted will cause the compartment to be connected to more or fewer compartments because of an inter-deck connectivity, then the difference is significant and the Ship's Geometry must be redone (Section C.3.5.)

The blanks to be filled in during or after the ship visit are:

- **MAL DATA** - As explained in Appendix J, the Magnitude of Acceptable Loss should account for life safety (LS), property protection (PP), the ship's primary mission (PM), and its secondary mission (SM). Each consideration may be assigned a MAL, and the MAL's may be integrated into the one integer which SAFE requires.
  Appendix J discusses possible weighting factors to use for combining the four MAL's into one. Only the one MAL for each compartment will be entered into the SAFE database as described in Section C.4.3.1, but this Ship Visit Form should be kept to document the MAL data used to derive the one value.

- **FSO'S MAL (Magnitude of Acceptable Loss)** - This value combines the considerations discussed above into one integer rating from 1 to 4 defined in Appendix J and *Theoretical Basis*, Chapter 6.6.1. The rating represents the magnitude of fire damage which is considered acceptable for this compartment to sustain.

- **FSO'S FAL (Frequency of Acceptable Loss)** - This value, in years, represents the frequency with which this compartment may sustain the given MAL. Allowable FAL values are integers between 1 and 30 years. Guidance for assigning FAL is also contained in Appendix J.

- **Frequency of EB** - Because the frequency of EB (in fires reaching established burning/compartment year) is derived from historical fire data on both Coast Guard and Navy vessels, it should only be altered by the user with great caution. One good reason for modifying frequency of EB is if more accurate historical fire data is available for each CUI for ships of the type being analyzed. This data could be utilized to calculate new frequency of EB values for each CUI on the ship. For example, if there were 30 ships in the class being analyzed which had been in service for 10 years each, the denominator of 300 compartment years would be used. The numerator would consist of the number of fires which reached EB in compartments of a given type. Thus, if a total of 4 fires reaching EB in compartments with a CUI of EM (Main Propulsion-Mechanical) had occurred on all ships in the class during their 10 years of service, their frequency of EB would be 4/300 or 0.0133.

A discussion of frequency of EB may be reviewed in Chapter 5.3 of the *Theoretical Basis*, and the SAFE frequency of EB assignments by CUI are printed in Appendix F of this manual. The frequency of EB is utilized in SAFE when the target option of the probabilistic model is selected. For each fire path in which a target is considered lost, the probability of loss of the target is multiplied by the frequency of EB of the path's room of origin in order to determine the relative frequency of loss of the target *given Fire Free State* (FFS) as opposed to *given EB*.

Needless to say, frequency of EB values would not be filled in during the ship visit, but would require research and calculation to determine appropriate values for each CUI or each individual compartment. Even the experienced user should leave this column blank and use SAFE defaults for frequency of EB, unless serious consideration has been given to the reasons for change.

- **% Time Sea, % Time Port** - These values represent the percentage of time that a compartment is **monitored** at sea and in port. A compartment may be monitored in two ways: by the crew when occupied, or by a detector servicing the compartment. On ships where detectors are minimal, these values are best assigned by the officers on board the ship who are aware of normal manning levels at sea and in port.

  The reliability of the detector itself should NOT be considered when assigning the values, so compartments which are serviced by a detector should be given a value of 100%. (Reliability of detection should be accounted for in the assignment of A and M values, not in the % Monitored values.) Compartments which are continuously occupied should be assigned a value near 100% as well. Detectors need not be located in the compartments which they service. On small ships, if an audible alarm can be heard throughout the ship, the % monitored values could be nearly 100% in all compartments. On large ships, if the detector is not wired to a remote location and it cannot be heard throughout the ship, an appropriate percentage significantly less than 100% should be estimated for the compartment in question.

  Refer to the % Monitored Sea and % Monitored Port portions of Appendix E for suggested ranges for these two values. Note that these suggested ranges in Appendix E INCLUDE the presence of detectors in CUI's where detectors are commonly located. If a compartment with a default of near 100 is NOT serviced by a detector, adjust the value downward accordingly. If a detector services a compartment, remember to record the detector on the Detection/Fixed Suppression Systems form (Section C.3.3.5).

C.3.3.2. I Values Form

The determination of the **I** (on this form), **A**, and **M** values used in SAFE is discussed in detail in the *Theoretical Basis*, Chapter 6.3. These three are probabilities measuring the likelihood of fire self-termination (I), automated suppression (A), or manual suppression (M). The numerical measure of probability is generally expressed as a value between 0.0 and 1.0.

A probability of 0.0 indicates that an event will never happen, while a value of 1.0 indicates that it will always happen. I, A, and M values in the SFSEM are expressed as a percentage between 0 and 100 rather than as a probability between 0.0 and 1.0. For example, a 90% chance that a fire in a given compartment will self-terminate is assigned an I value of 90.

A brief refresher of the **I** value is given here:
The I value is the probability that a fire in a compartment will self-terminate prior to reaching FRI given:

EB the compartment is the room of origin (1-$\bar{\mathbf{I}}$ below).
TBAR the fire enters the compartment via barrier thermal failure.
DBAR the fire enters the compartment via barrier durability failure.

The components used to calculate I given EB (expressed I|EB) are probabilities that the fire will NOT self-terminate:

$\overline{\mathbf{Ie}}$ - before growing to enclosure.

$\overline{\mathbf{Ic}}$ - before growing to the ceiling.

$\overline{\mathbf{Ir}}$ - before growing to full room involvement.

When these three components are multiplied, the product is $\bar{\mathbf{I}}$, the probability that the fire will not self-terminate in this compartment. **I|EB** equals 1 minus this product.

During or after the ship visit, the user may either enter $\overline{\mathbf{Ie}}$, $\overline{\mathbf{Ic}}$, and $\overline{\mathbf{Ir}}$ on this form and let SAFE calculate **I|EB** when the components are entered in the SAFE compartment spreadsheets in Section C.4.3.2, or may skip directly to entering **I|EB** directly on the form, ignoring the breakdown into component assignments.

I|Tbar and **I|Dbar** values for each compartment may be assigned by the user directly on this form and entered in the SAFE compartment spreadsheets in Section C.4.3.2, or the user may let SAFE calculate **I|Tbar** and **I|Dbar** values when the components are entered in the SAFE compartment spreadsheets. The calculations are based on formulas in Appendix G.

The "**Most Probable Sources of Ignition**" notes will not be entered into SAFE but should be completed to provide documentation for values assigned.

C.3.3.3. Vents Form

Vents are used to model miscellaneous openings in bulkheads and decks as well as actual vents. A vent may be used to represent the gap under a joiner door or a hole through which a cable passes. A vent which connects two compartments should be included in both. Doors and hatches are not considered vents.

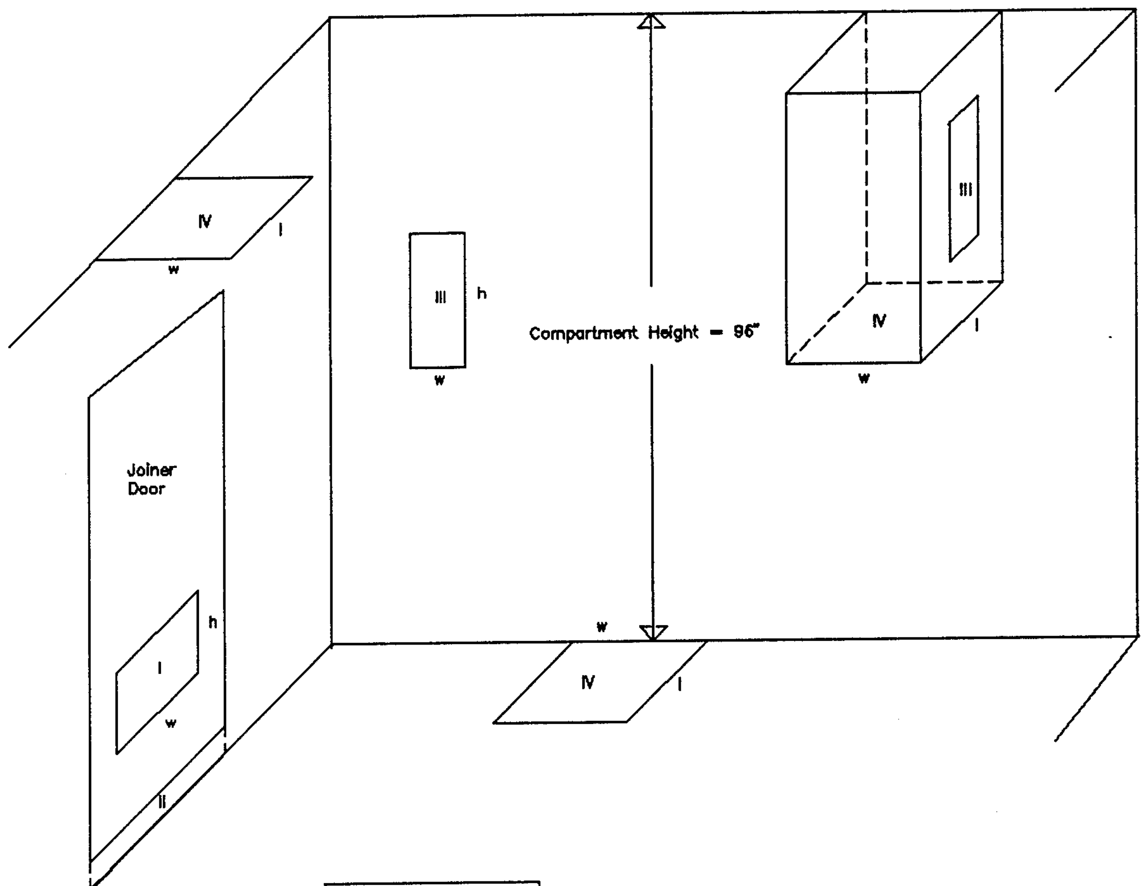
SAFE will utilize a total vent area and average vent height for each compartment. Total vent area is simply the sum of all the vent areas in the compartment. Average vent height is the average height of all vent openings. These values are defined in the Glossary of the *Theoretical Basis* and are used in conjunction with the door and hatch opening sizes to calculate the heat release rate in the fully-developed fire regime (*Theoretical Basis*, Chapter 6.3.4.1) and to calculate the time to Full Room Involvement (*Theoretical Basis*, Appendix B). Refer to Figure IV-2 and VENT NOTES below for more information on representing several common types of vents.

Only four types of vents per compartment are allowed. If more than four types exist, group two similar types together.
For each type of vent in the compartment, record the following:

NDVH	"N" for NO vents in a compartment; "D" to use default area and height (printed in parentheses after the CUI); "V" or "H" for vertical or horizontal if a vent type being entered.
#	Number of vents of this type and size
Wid	Width in inches of the vent opening
H/L	Height in inches of a vertical vent opening or length of a horizontal vent.

The width and height (length) measurements entered are used by SAFE to calculate the vent area. The height of a vertical vent is also used to derive the average vent height, while for a horizontal vent, SAFE will use the compartment height (in inches) as vent height (See the *Theoretical Basis*, Chapter 6.3.4.1.)

The total vent area ($in.^2$) and average vent height (in.) for each compartment will be calculated after the ship visit by the SAFE program when information about each vent type is listed.



		Ship Visit Form					
Vent	Type	V/H	#	Size (in.) w	Size (in.) h/l	SAFE Hgt (in.)	SAFE Area (sq.in.)
I	Door Louver	V	1	20	12	12	240
II	Door Space	V	1	36	1	1	36
III	Vertical Vent	V	2	10	30	2 x 30	2 x 300
IV	Horizontal Vent	H	3	24	20	3 x 96	3 x 480
	SAFE Average Vent Height					52	2316 SAFE Total Vent Area

V/H = Orientation of Vent (Vertical or Horizontal)

w = Width of Vent

h/l = Height of Vertical Vent or Length of Horizontal Vent

Figure IV-2 Vent Form Example

VENT NOTES:

- The effective area of vents with louvers should be estimated from the outer area of the vent less an approximation of the area occupied by the louvers. The same also for holes containing cables, pipes, or stuffing.

- The gap UNDER each joiner door (excluding doors representing windows and weathertight doors) should be added as a vent the height of the gap times the width of the door to the compartments on both sides of the door.

- If a bulkhead does not connect completely to the deck above, the area at the top of that bulkhead should be treated as a vent to ALL compartments adjoining that bulkhead.

- Compartments joined by a zero-strength barrier (e.g., Engine Room and Uptakes), must have the **combined** total vent area and height of **both** compartments assigned to both compartments; i.e., both compartments should have the same values for total vent area and height. Do not count the zero-strength barrier itself as a vent.

- Round vent openings may be assigned a width equal to the area divided by the diameter and a height equal to the diameter.

- If a vent connects two adjacent compartments, then the vent should also be considered a penetration in the barrier and the barrier should be derated on the barrier data plots (See Section C.3.4).

C.3.3.4. Fire Growth Models and Fuel Load Form

- **Fire Growth Model** - The fire growth model assignment determines how Qmax (maximum heat release rate) and alpha (pre-FRI fire growth rate) will be calculated by SAFE. Refer to Appendix C of the *Theoretical Basis* for information on each model. The Reference Data Form also lists available models.

- **% Stack Height** - Enter the height of the fuel stack as a percentage of the total compartment height for models 1-3 only. (Not required for other models).

- **% Deck Area** - Enter the percentage of the deck area occupied by the fuel as required by the fire growth model chosen for each compartment. It must be greater than 0 if **any** fuel load is present. Conversely, it must be 0 if **no** fuel is present.

- **Cellulosics, Plastics, and Flammable Liquid** - See the Glossary, Appendix E, and Chapter 6.1.4. "Fuel Load" from the *Theoretical Basis* and the "Fuel Load Defaults and Ranges" from Appendix E of this manual.

  The ship visit form will request that the cellulosic and plastics components of the fuel load be recorded in one of two ways, depending upon the choice made when the ship was first entered in SAFE (Section II.C):

  1. Recorded directly as psf (the AVERAGE pounds per FOOT^2 of these components for the entire compartment). SAFE defaults for cellulosics and plastics in psf are printed in parentheses after each CUI.
  2. Recorded as total pounds in the COMPARTMENT letting SAFE convert to psf upon entry into the data entry screen described in Section C.4.3.4. Since No SAFE defaults exist for cellulosics and plastics as total pounds per compartment, none are printed in parentheses after each CUI.

  Flammable liquid will always be entered as total gallons per compartment. Bilge water, if contaminated with oil or fuel, is considered flammable liquid for this purpose. When a fuel load is in a protected environment, such as flammable liquids in airtight steel containers or cellulosics enclosed in filing cabinets or lockers, the values assigned to the fuel load should be reduced using engineering judgment to reflect delayed ignition.

Flammable bulkhead or deck coverings should be considered as fuel load (either plastics or cellulosics).

These three components of fuel load (cellulosics, plastics, and flammable liquids) are converted to their cellulosic equivalent in kiloBTU's/ft^2 by SAFE using the following formula:

$$FL = ((C * c_1) + (P * c_1 * 2) + (F * c_1 * 2 * c_2))/A)$$

where:

- FL = equivalent cellulosic fuel load in kBTU's/ft^2
- C = cellulosics in pounds/ft^2
- P = plastics in pounds/ft^2
- F = flammable liquid in total gallons
- A = area of compartment in ft^2
- c_1 = conversion of pounds cellulosic to kBTU's (8 kBTU/pound) [4, p. 3-28, Table 5-3E]. Note that both plastics and flammable liquids contain approximately two times the heat energy per pound as cellulosics [4, p. 8-34].
- c_2 = conversion of gallons of flammable liquid to pounds (8 pounds/gallon) [5, p. 1-19 and 4, p. B-3]

♦ **Major Sources** - This area is for notes on the compartment's fuel load. These notes will not entered into SAFE but should be completed to document the values assigned.

C.3.3.5. Detection/Fixed Suppression Systems Form

Detection and Fixed Suppression systems affect the probabilistic model only because they influence the assignment of A and M values by the user. However, it is useful to have a printed record of each compartment's systems to refer to when assigning A and M values.

While Automatic Detection Systems may protect compartments other than those in which they are located, Fixed Suppression Systems must be in the compartment they protect. Thus, enter the number of each type of Automatic Detection System AVAILABLE TO the compartment and the number of each type of Fixed Suppression System INSTALLED IN the compartment. If no systems are available to or installed in a compartment, enter a 0.

The Reference Data Forms should be used as needed to decode the types of systems listed. If a system available for use in the compartment is not listed, make note of it on the form so that it may be accounted for when assigning M values. The effect of these systems in each compartment must be reflected in the A and M values assigned by the user in the A & M Values Form (See Section C.3.3.7).

C.3.3.6. Manual Suppression Systems Form

Like Detection/Fixed Suppression systems, Manual Suppression systems affect the probabilistic model only because they influence the assignment of M values by the user in the A & M Values Form in the next section. However, it may be desirable to have a record of each compartment's systems. Record the number of manual suppression systems AVAILABLE FOR USE by each compartment using the Reference Data Forms to decode the types of systems listed. If no systems are installed or available to a compartment, enter a 0.

When referring to portable extinguishers, AVAILABLE FOR USE to the compartment implies that the extinguisher is located within the same watertight subdivision as the equipment which it protects, no more than 30 feet away and no more than one deck above or below (See Code of Federal Regulations [6]). Similarly, fire main stations would not need to be located in a compartment to be available to the compartment. If a system available for use in the compartment is not among those listed on the Reference Data Forms, enter it on this form so that it may be accounted for when assigning M values.

C.3.3.7. A & M Values Form

As indicated in the prior two sections, the A (Automated Suppression) and M (Manual Suppression) values assigned by the user must reflect the existence of both detection and suppression systems. Adding or removing a system will have no effect on the probabilistic modeling results unless a corresponding change is made to the A and M values of the affected compartments.

Refer to the *Theoretical Basis*, Chapter 6.3.2-3 for guidance in assigning the following three values for A and three values for M for each compartment, depending upon how the fire was started in the compartment:

- |**EB** - as the room of fire origin
- |**TBAR** - as an adjacent compartment entered by Tbar failure
- |**DBAR** - as an adjacent compartment entered by Dbar failure

While the A & M form is included in the ship visit package, it is recommended that A and M values not be assigned until after Full Room Involvement (FRI) Time has been calculated. SAFE calculates FRI time, then allows the user to adjust the calculated FRI time if it appears to be unreasonable or if a more appropriate method is utilized to calculate it. Since A and M values reflect the probability that the fire will be suppressed before FRI is reached, these values will vary depending upon what FRI time is determined to be.

The probabilistic model uses the A and M values to determine whether a compartment will be able to contain a fire using automated or manual suppression.

It is worth noting that M values are assigned assuming the ship is at sea. Because of the varying degree of manual fire protection that is available in port, it is difficult to assign M values for the "in port" condition. See Section V.H.4 for suggestions on effectively modeling manual fire protection for the "in port" condition.

C.3.4. Ship Visit Forms--Barrier Data Plots

The ship visit provides a final opportunity to double-check the modeling decisions made in creating SHIP.DWG. The barrier data plots will be used to record openings, materials, and strength derating for any barrier that adjoins a compartment considered in the analysis. Use these plots also to record geometry changes or corrections that must be made to SHIP.DWG after the ship visit.

The barrier data plots are plan view plots of SHIP.DWG. Each s-layer should be printed in as many sections as necessary so that each section is large enough to allow the required information to be recorded. Printing on legal size paper may also be helpful. Figure IV-3 shows one completed barrier data plot.

C.3.4.1. Creating the Barrier Data Plots

- Enter SHIP.DWG in AutoCAD by selecting:
  "Ship Visit Form--Barrier Data Plots" from the "Prepare for Ship Visit" menu;
  or "Prepare AutoCAD Drawing" from the "SAFE Main" menu;
  or "Data Entry Worksheets and Forms" from the "View/Print Reports and Forms" menu.

- **D2** layers s-1 and o-1 (not 0-1) then **ZOOM WINDOW** around the first portion of the deck. The portion should be small enough to ensure that the resulting plot will be of a usable scale. If any hatch blocks have been entered into the drawing, they should be on o-layers, so both s-1 and o-1 should be printed.

- **INSERT** the REMINDER block and enter the ship name, deck name, and description of the portion to be printed using the **DTEXT** command, ensuring that all items will be visible when the portion is printed but that these items do not conflict with the plan view.

- Print the portion using the **PLOT** command.

- When printing is complete, **ZOOM WINDOW** around the next portion of the deck and repeat the process. The REMINDER block, ship and deck names, and description may be **MOVE**d over from the previous portion and edited.

- Repeat for each s-layer and its o-layer.

- **QUIT** the drawing when finished so that the REMINDER block doesn't become part of the drawing. If the drawing is accidentally saved with the REMINDER blocks, they may be erased at a later time.

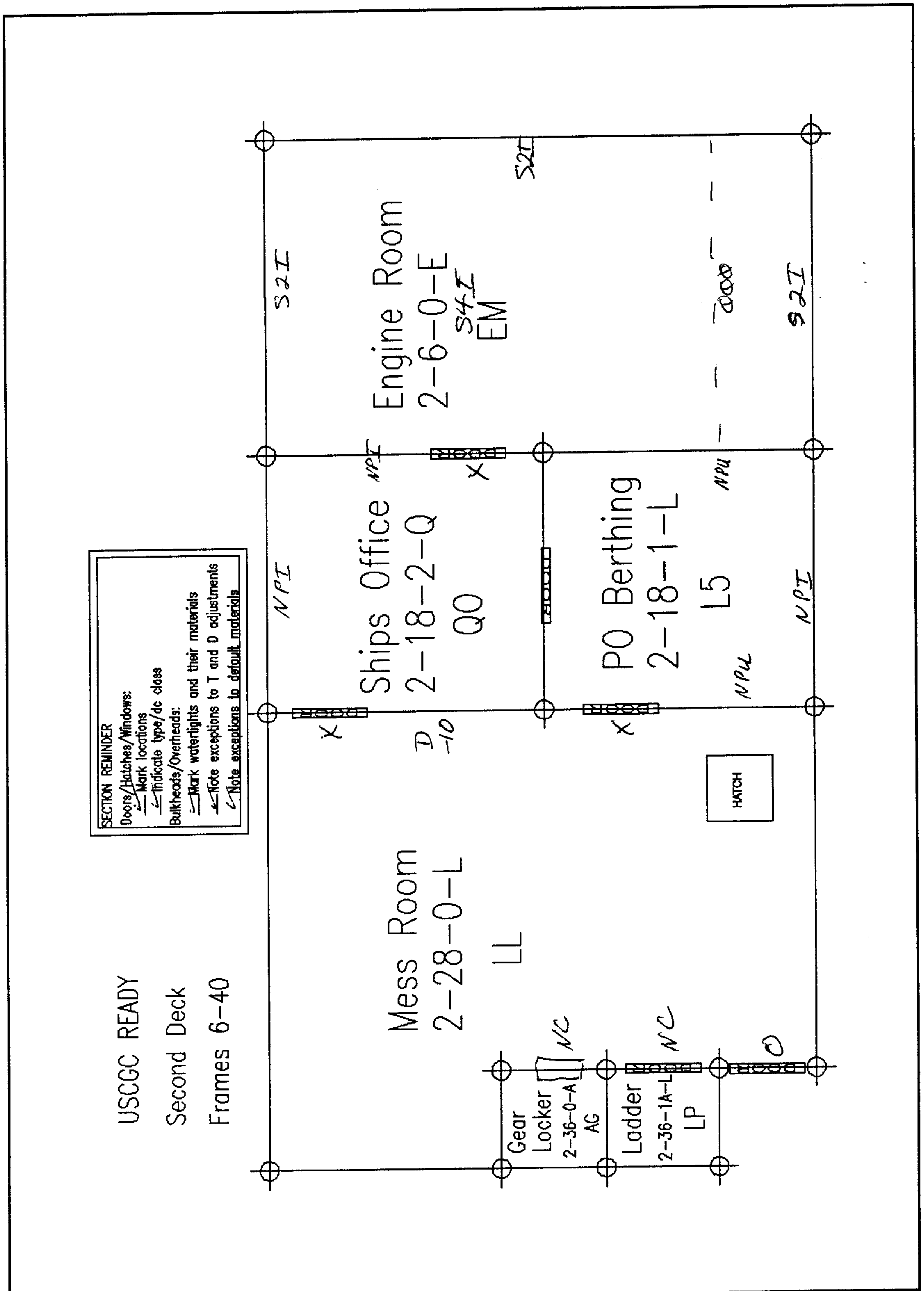


Figure IV-3 Sample Completed Barrier Data Plot

C.3.4.2. Completing the Barrier Data Plots:

During the ship visit, record the following information as necessary for each barrier:

- **Bulkhead/Overhead Material ID Exceptions and Watertights** - Referring to the Reference Data Forms and material assignments made on the Overall Ship Data Forms, assign exceptions to the material IDs established as the default. If the barrier material is not on the SAFE material list, select a material which is most like it. Or, if all the material's properties can be determined, a new material may be added in Section C.5.1.

  The default barrier material assignments made on the Ship Data Forms will assign all barrier materials to all barriers, so these barrier data plots should be used only to note exceptions to bulkhead facing materials, overheads, and watertight barrier materials. Don't forget to label zero-strength barriers. Note that if barrier materials were assigned to interior barriers by CUI, these assignments will overwrite the overall ship barrier material defaults. Thus, exceptions to defaults by CUI must be noted rather than exceptions to the overall defaults.

  Bulkheads: A single bulkhead is assigned up to three barrier materials from the list in Appendix A:

  - A weather bulkhead must have assigned an exterior material and an interior facing material even if it is the same as the exterior material. (1-2 different materials)
  - An interior (non-watertight) bulkhead must have a facing material on each side which may or may not be the same material. (1-2 different materials)
  - An interior watertight bulkhead must have a "core" watertight material and a facing material on each side even if it is the same material as the core. (1-3 different materials)

  SAFE considers the properties of all **unique** materials in the analysis of the bulkhead. If the same barrier material is entered for each side of a bulkhead (and for the core if it is a watertight bulkhead), SAFE assumes that this as one barrier material, not two or three. But if two (or three) different materials are assigned to a bulkhead, or if the same material is separated by a different material, such as the watertight core, then the properties of all materials assigned are utilized. See Appendix L for a discussion of SAFE's method of accommodating a combination of barrier materials in one bulkhead.

Color coding the bulkhead material exceptions is a clear, concise way of marking the form. Alternately, the material ID may be written next to the bulkhead exceptions.

Overheads: **REMEMBER: All horizontal barrier assignments are made to a compartment's overhead connections, not to its deck.** To make an assignment to a compartment's deck, it must be made to the overhead of the compartment below it. See the Note in Section C.1.2 for an overview of how horizontal barrier values are assigned in SAFE. Unlike bulkheads, overheads have only one barrier material. By assigning an overhead's material, the deck of the compartment above is also being assigned.

When an entire compartment's overhead is an exception to the overall ship default overhead material ID, record the exception between the compartment's name and plan ID. When only a portion of the compartment's overhead is an exception, record it at the approximate location of the overhead and outline it with the approximate shape of the exception.

For example: If the default overall ship deck assignment is "S4U" (1/4" steel) and the Engine Room's overhead is insulated, the Engine Room's overhead should be assigned a "S4I" (1/4" steel with thermal insulation). This overhead material ID exception should be recorded between the name and plan ID of the Engine Room. In addition, only the overhead connection between the Engine Room and the Uptake is zero-strength and should be assigned a "000", not connections between the Engine Room and other compartments above it. This "exception to the exception" should be recorded on the plot of the Engine Room at the approximate location of the uptake and outlined with the approximate shape of the Engine Room/Uptake connection. See Figure IV-3 for an illustration of this example.

- **T and D adjustment** - Just as for the overall ship, the barrier may not be in "like new" condition. If a barrier's weaknesses could result in an earlier **thermal** or **durability** failure than would occur if the barrier were "like new", then it should be derated by entering a value between -1 and -99% for T and D adjustment. In addition, ventilation in a barrier which connects the barrier's two adjacent compartments would also justify a T and D adjustment. A good example of this type of ventilation would be the louvered vent in, and space under, a joiner door. Enter a value between -1 and -99% next to a bulkhead marking the approximate location of the weakness if it is localized.

The strength of that barrier can be "derated" by that percentage, replacing the default derating assignment made for the entire ship on the Ship Data Forms. If a bulkhead intersects a false ceiling but does not completely connect to the deck above, derate the bulkhead up to -99 depending on size of gap created. Only one derating value for T and one for D may be applied to each barrier, NOT one for each barrier material assigned.

Similarly note any specific deck or overhead connections that should be derated to a different percentage from the default derating assignment made for the entire ship by writing the derating percentages at the approximate location of the weakness. For example, if the corner of a compartment has a pipe penetrating the overhead with an air gap surrounding it, this overhead should be derated only where it connects to the compartment above the penetration, not the entire compartment unless the entire compartment has only one overhead (is connected to only one compartment above).

- **Openings** - Verify the location of each opening (door, hatch, ladder opening, OPERABLE window). If an opening is observed that isn't drawn on the barrier data plot, draw it and assign its type and DC rating. (Refer to the Opening types listed on the Ship Visit Form - Reference Data)

If a compartment has an operable window, there must be a door of the appropriate type and DC rating (see OPENING NOTES below) representing it. Multiple small exterior windows in a compartment (or one barrier) may be combined and represented by one door, even if the total area of all small windows is less than or slightly greater than 400 in.^{2}. The windows must have the same DC rating in order to be combined. Larger windows with an individual area near 400 in.^{2} may each be represented by a door in the appropriate barrier. Doors representing multiple exterior windows should be entered in an EXTERIOR bulkhead.

OPENING NOTES:

- Doors (types beginning with "D") may be entered in bulkheads only, not overheads. Record the opening type code and damage control readiness (DC) rating for each door on the barrier data plots near each door block. Again, refer to the Reference Data Form for the opening type codes and the DC rating.

- Watertight doors may be used in any bulkhead desired, not just a watertight one.

- Doors with no ratings should be classified as either joiner doors normally open (DJ/NO) or normally closed (DJ/NC), or open doorways (DO).

- Unrated weathertight doors (NOT watertight) may be represented by joiner doors (DJ/NC or DJ/NO), OMITTING the gap normally assigned on the Compartment Vents Form.

- Rated operable windows must be modeled as watertight doors of the DC class of the window.

- Non-rated operable windows are entered as joiner doors (DJ/NC or DJ/NO), OMITTING the gap normally assigned on the Compartment Vents Form.

- Passing windows with overhead rolling steel doors typically found between the galley and the mess room are treated in the same manner as conventional windows.

- Non-operable windows and bolted access plates may be disregarded.

- Hatches and scuttles (types beginning with "H") are entered in overheads only, not bulkheads. They should be marked on the overhead of the LOWER of the compartments they connect and may have an X, Y, or Z rating or, if an open ladder hatch, O.

When a page of the barrier data plots is thought to be complete, use the Section Reminder box to ensure that:

- all openings have been recorded and assigned a type rating;
- all watertight bulkheads have been marked and assigned a barrier material if the material is contrary to the default;
- all barrier material exceptions have been noted (including 0-strength barriers);
- all barrier deratings (T and D adjustments) have been assigned.

Then proceed with the next page of the barrier data plots.

C.3.5. After the Visit: Making Changes to Ship's Geometry

Changes and/or corrections to the compartment geometry found during the ship visit must be made to the ship's geometry which then must be re-loaded into the database before the compartment or barrier values may be entered.

It is necessary to have complete ".DXF" files for all layers in order to redo the ship's geometry. Before entering the SAFE program to make changes to SHIP.DWG and generate new ".DXF" files, check for the presence of "*.SAV" files in the \SAFE\IO directory. If ".SAV" files exist, read Appendix N on reusing these files to avoid recreating all new ".DXF" files.

Then enter SAFE and choose "Prepare AutoCAD Drawing" from the SAFE Main Menu. Make the desired changes to the compartment polylines, following the rules and guidance given in Chapter III, especially Section F. When changes are completed, follow the instructions in Section III.G to produce new ".DXF" files for any layers where changes were made and any layers which were not restored from the ".SAV" files.

Then repeat Section C.1 of this chapter to create and load the revised geometry. Once the ship's geometry has been updated, proceed with Section C.4 below.

C.4. Assign and Tailor Compartment Values...

This option appears on the "Enter Compartment/Barrier Data" menu.

NOTE: All Ship Visit Forms must be filled out for each compartment (or a representative of each compartment) before this section is begun. All of the information on the ship visit forms - compartment data spreadsheets will be entered into SAFE through this menu and its submenus.

Review carefully the values assigned on the ship visit to see if a compartment of a given CUI has values assigned which are inconsistent with other compartments with that same CUI, or which are simply inconsistent with the defaults assigned to CUIs in Appendix F. Since the CUI is potentially used to assign many fire parameters, it is recommended that the CUI be changed both on SHIP.DWG and in the database (Section C.2.3.) before proceeding beyond this point of the analysis.

This section allows for the assignment of values to each compartment's fire parameters. The selections available go from the most general level of assignment to the most specific level and the user may choose to select one or all of the levels beginning with the general ("Assign SAFE CUI Defaults") and ending with the specific "Assign/Adjust Values by Compartment".

The user has the option to:

	C.4.1.	Assign SAFE CUI Defaults (Most general) Uses the SAFE default values for each parameter. These values were assigned for each CUI by SAFE's developers;
AND/OR	C.4.2.	Assign/Adjust Default Values by CUI Assigns the user's own default values by CUI for some or all of the parameters;
AND/OR	C.4.3.	Assign/Adjust Values by Compartment (Most specific) Assigns compartment values individually for some or all of the parameters.

After any of these options, if values are incorrect or incomplete, another menu choice appears:

C.4.4. View/Print List of Incomplete Values.

C.4.1. Assign SAFE CUI Defaults

This section uses default values established by SAFE's developers for each fire parameter for each CUI in the SAFE database. Refer to Appendix F for a listing of those defaults. Selecting this option causes these default fire parameter values to be assigned to each compartment on the ship by CUI. This option is not required and should NOT be selected when an experienced user is analyzing a small ship and has assigned specific values for each compartment on the ship during ship visit. In that case the user should skip both this option and the next option ("Assign/Adjust Default Values by CUI" described in Section C.4.2) and proceed to tailor values by selecting "Assign/Adjust Values by Compartment" described in Section C.4.3).

The option,"Assign SAFE CUI Defaults", is recommended in the following cases:

- When analyzing a ship design where it would be impossible to obtain detailed and accurate information about the ship.
- For the inexperienced user who would like to conduct a "rough" fire analysis in order to understand how SAFE works without spending the time to fine tune values and without needing accurate results.
- When it is a "first step" to assigning compartment fire parameters and the user is intending to perform the "second step" and/or "third step" offered in the next two sections to tailor some, but not all, of the SAFE defaults assigned.

NOTE: SAFE default values reflect the presence of automated fire suppression systems and detectors in CUI's where they are commonly placed. If SAFE defaults are accepted, % Monitored at Sea and in Port, as well as A and M values, should be reviewed and adjusted, if necessary, on a compartment by compartment basis. To do this, select "Assign/Adjust Values by Compartment" (Section C.4.3) if more accurate information about detection and suppression is available.

Assigning the SAFE defaults to each CUI for each fire parameter may take several minutes. When finished, the compartment assignments in the database are checked for completeness. For one group of fire parameters, fire growth model information, SAFE defaults are not available and will not be assigned using the "Assign SAFE CUI Defaults" option. Fire growth model information must be assigned by the user, either by CUI or by compartment. After SAFE defaults are assigned, the user will be informed that compartment values are complete except for fire growth model information, then returned to the "Compartment Values" menu.

C.4.2. Assign/Adjust Default Values by CUI...

This option involves the user in assigning defaults for each fire parameter to each CUI. It is recommended in the following cases:

- For the inexperienced user. This option allows the user to become familiar with the ranges of acceptable and normal values for the fire parameters, enabling a more accurate selection of an assigned value for each CUI. In this case, this option will probably be preceded by assigning of SAFE default values by CUI and be followed by individual compartment assignments described in Section C.4.3 below.
- When analyzing a very large ship. Making assignments by CUI may be more efficient than individually assigning values to each compartment during a ship visit and transferring that information to the SAFE spreadsheets (Section C.4.3). It may be more accurate than simply using the SAFE defaults described in the previous section. Some tailoring of each compartment in Section C.4.3 may be desirable after these more general CUI assignments are made.
- To complete the assignment of compartment values that were assigned by SAFE defaults as described in Section C.4.1. (There are no SAFE defaults for fire growth model information.) The user may assign fire growth model information by CUI by selecting this option or may assign fire growth model information on a compartment by compartment basis by selecting "Assign/Adjust Values by Compartment." (See Section C.4.3.)

If this option is chosen, the "Assign/Adjust Default Values by CUI's" menu will appear, listing the fire parameters to be assigned by CUI. Select the desired parameter from the list presented.

Note that several CUI screens may need to be used to enter the information from one compartment data spreadsheet, i.e. "Percent Monitored at Sea" and "Percent Monitored in Port" as well as "FSO's, Frequency of EB" to enter all the values from the spreadsheet "FSO's, Frequency of EB, % Monitored".

If the user previously chose to enter Cellulosic/Plastic Fuel Load as total pounds per compartment, they cannot be assigned here by CUI.

When a parameter is selected from the list, an entry screen will appear listing CUI's on the ship along with their SAFE default values. For many parameters, a "Normal" range has been assigned and is also displayed. The absolute range for the parameter is given in a message at the bottom of the screen. An entry by the user in the "Adjusted Value" column is allowed to be outside the NORMAL range, but not outside the ABSOLUTE range. Appendix E lists the normal ranges and SAFE default values for each CUI.

If SAFE defaults were assigned in Section C.4.1, the "Adjusted Value" column will contain the SAFE default value, but if not, the "Adjusted Value" column will be blank and values may be assigned for each CUI on the screen. In the latter case, the screen provides instructions for assigning SAFE default values to the "Adjusted Value" column if so desired. The data for the "Adjusted Value" assignments should come from the Compartment Data Forms completed in Section C.3. For each CUI, compare the parameter's values on the Compartment Data Forms with the absolute and normal ranges for that parameter, and assign a value which takes both the Compartment Data Forms and the ranges into account. Compartments with exceptions to the newly-assigned value should be circled on the Compartment Data Forms. These exceptions will be entered in Section C.4.3.

Choosing the "View/Print CUI Values Assigned" option will allow printing of a current report of the values assigned to each CUI for each parameter. These reports are also available by selecting "User Assignments by CUI" from the "View/Print Reports and Forms" menu. When all desired parameters on the "Assign/Adjust Default Values by CUI" menu have been selected and all values assigned, choose "Return to Previous Menu" which will cause a check for completeness of compartment values (Section C.4.4).

C.4.3. Assign/Adjust Values by Compartment...

This option is recommended for the following reasons:

- For fine tuning exceptions to assignments made in Sections C.4.1 or C.4.2 above.

- For small ships where a ship visit enabled detailed information to be obtained about each compartment. In this case Sections C.4.1 and C.4.2 should be skipped so that when the user enters the SAFE compartment spreadsheets, the fire parameters are blank. Blank screens make it easier for the user to enter tailored values for each compartment without overlooking some tailoring because values have already been assigned by CUI.

- To complete the assignment of compartment values that were assigned by SAFE defaults as described in Section C.4.1. (There are no SAFE defaults for fire growth model information.) If the user chooses not to assign fire growth model information by CUI (Section C.4.2), then this information must be assigned on a compartment by compartment basis by selecting the appropriate choice from the "Assign/Adjust Values by Compartment" menu.

If this option is chosen, the "Assign/Adjust Values by Compartment" menu will appear, listing the general areas to be selected for entry of specific fire parameters in spreadsheet-style screens, compartment by compartment. These general areas correspond to the Ship Visit Form - Compartment Data sheets.

The compartments on each screen are listed ordered by CUI, and within the same CUI, by deck from the bottom of the ship up. This is the same ordering that was provided on the Ship Visit Forms. **However, if any one compartment's CUI was changed (Section C.2.3) after the ship visit forms were completed, the compartments' order on the screens will be DIFFERENT from that on the ship visit form and great care must be taken in transferring data from the form to the screen.**

If neither of the two prior steps (Sections C.4.1 or C.4.2) were executed, all spreadsheets must be entered and all blanks filled on each spreadsheet. In general the spreadsheets are self-explanatory, although several may require additional explanation or instructions provided below.

C.4.3.1. FSO's, Frequency of EB, and % Monitored Screen

Values on this screen MUST be complete before the probabilistic model can be run.

Compartment height is displayed on this screen to verify any changes made to the ship's geometry after the ship visit as described in Section C.3.5. If incorrect compartment heights were noted on the ship visit forms and the ship's geometry was redone to correct the problem after the ship visit, the compartment height printed on the screen should reflect that correction.

The four values for MAL DATA on the ship visit form must be combined (see Appendix J) and entered as one value under MAL.

All other information should be taken from the FSO's, Frequency of EB, % Monitored Form as described in Section C.3.3.1.

C.4.3.2. I Values Screen

Values on this screen MUST be complete before the probabilistic model can be run.

Refer to the discussion of I values in Section C.3.3.2. This screen is intended to provide flexibility in entering the probability of flame self-termination (I values).

If $\overline{Ie}$, $\overline{Ic}$, $\overline{Ir}$, the three components used to calculate I given EB (expressed I|EB), have been assigned by the analyst, then entering these three components in the appropriate columns will allow SAFE to calculate I|EB. On the other hand, if the analyst has assigned I|EB directly, then the components may be left blank and I|EB may be directly entered.

Again to provide flexibility, once the I|EB value is determined, the values for I|TBAR and I|DBAR will be calculated automatically using the equations in Appendix G. The results of these calculations are displayed at the top of the screen. The user may accept the calculations for these two parameters by pressing **<F5>** or may assign new values by pressing **<enter>**.

To avoid frustration, be sure to follow directions printed in yellow above the compartment listing.

C.4.3.3. Vents Screen

Values on this screen MUST be complete before FRI can be calculated.

Refer to the discussion of vent assignments in Section C.3.3.3. This screen allows entry of up to four types of vents for each compartment with multiple vents of each type. The compartment's total vent area and average vent height are automatically calculated by SAFE using the values entered. If defaults were assigned for vents by CUI, the total vent area and average vent height will be printed for each compartment when the cursor is on that compartment's row. Individual vent data may be entered which will cause recalculation of the compartment's total vent area and average vent height; however, the recalculation will not occur until the screen is exited.

If a compartment has no vents, enter "N" in the first column of Vent Type #1 and use the arrow keys to move to the first column on the next line. If the CUI default for vent area and vent height is to be used, enter "D" in the first column and again use the arrow keys to move to the next line. Otherwise, enter "V" for vertical or "H" for horizontal vent of vent type #1 and for each subsequent vent in the compartment. The remaining columns for each vent type correspond to the vent data ship visit form and are explained in Section C.3.3.3. Note that it is not necessary to enter four vent types for each compartment, but no more than four types may be entered. If a compartment row is left blank and CUI defaults were assigned, the defaults will be used; however, if no defaults for vent data were assigned, each compartment must have a value entered in the first column, be it "N" (no vents), "D" (use default), "V" (vertical vent type) or "H" (horizontal vent type).

C.4.3.4. Fire Growth Models, Fuel Loads Screen

Values on this screen MUST be complete and correct before FRI can be calculated.

Refer to the discussion of fire growth model and fuel load assignments in Section C.3.3.4. This screen allows entry of cellulosics and plastics either as total pounds per compartment or in psf, depending upon which option was selected when the analysis was begun (Section II.C). If total pounds are entered, the corresponding psf values are calculated by SAFE and appropriately displayed.

C.4.3.5. Detection/Fixed Suppression Systems Screen

Values on this screen need only be entered if a database report listing them is desired.

Refer to Section C.3.3.5 and Appendix C if necessary to complete data entry of this screen.

C.4.3.6. Manual Suppression Systems Screen

Values on this screen need only be entered if a database report listing them is desired.

Refer to Section C.3.3.6 and Appendix C if necessary to complete data entry of this screen.

C.4.3.7. A & M Values Screen

Values on this screen MUST be complete before the probabilistic model can be run.

This screen will be displayed again after FRI has been calculated. It is recommended that A and M values not be assigned until then, or at least be reviewed after FRI has been calculated.

Refer to Section C.3.3.7 and Appendices E and G if necessary to complete data entry of this screen, which is intended to provide flexibility in entering the probability of automated suppression (A values) and the probability of manual suppression (M values).

Once the A|EB and M|EB values are determined, the corresponding values |TBAR and |DBAR will be calculated automatically using the equations in Appendix G and will be displayed at the top of the screen. The user may accept the calculations for these parameters by pressing **<F5>** or may assign new values by pressing **<enter>**.

To avoid frustration, be sure to follow directions printed in yellow above the compartment listing. (Note that this screen may not be exited unless the cursor is in the |TBAR or |DBAR column.)

C.4.3.8. View/Print Compartment Values Assigned

This option allows printing of the values assigned for each parameter in the same format as the Ship Visit Forms and the data entry screens just completed.

When all desired parameters on the "Assign/Adjust Values by Compartment" menu have been selected and all values assigned, choose "Return to Previous Menu" which will cause a check for completeness of compartment values for calculating FRI and running the model.

C.4.4. View/Print List of Incomplete Values

If compartment values are incomplete (i.e. if a blank was left in the "Adjusted Value" column of any CUI entry screen entered) or if there are errors in the fuel load vs. fire growth model information entered, the user is allowed to view or print a report showing which compartments have incomplete values or errors.

If the missing value will prevent the calculation of FRI, an 'f' is entered in the column corresponding to the missing value.

If any fuel load is assigned and the percentage of deck area occupied by fuel is 0
or if no fuel load is assigned and the percentage of deck area occupied by fuel is not 0,
an 'E' is entered in the FM field.

If the missing value will prevent the running of the model, an 'm' is entered in the column corresponding to the missing value. This applies particularly to A & M values which should not be completed until FRI is calculated.

This report will provide guidance making it apparent which menu choice from the "Assign/Adjust Values by CUI" or "Assign/Adjust Values by Compartment" menu must be selected to fill in the blanks and correct the errors.

When the necessary compartment values are complete, "Return to Previous Menu" and proceed with barrier assignments as described in Section C.5. below.

C.5. Assign and Tailor Barrier Values

This option appears on the "Enter Compartment/Barrier Data" menu.

NOTE: The Ship Visit Forms for Barrier Data plots must be filled out for all barriers (or at least the Ship Visit Forms for Ship Data) before this section is begun. Since barrier values may be assigned by CUI, a careful review of compartment CUI's should be made and any necessary changes made (Section C.2.3.) before continuing.

This section allows assignment of barrier materials and derating factors to all barriers on the ship. Barrier material assignment is very important in SAFE since barriers are the main component of passive fire protection. When a barrier is assigned a material, what is actually being assigned is the barrier's fire resistance or lack of it. Chapter 6.3.4.2 of the *Theoretical Basis* discusses barriers in the SFSEM.

Just as with assigning compartment values in the previous section, the selections available from this menu go from the general to the specific beginning with the general ("Review/Add Barrier Materials") and ending with the specific ("Enter Openings/Tailor Barriers in AutoCAD").

C.5.1. Review/Add Barrier Materials...

The list of barrier materials provided for selection in SAFE (See Appendix A or C.5.1.1 below) is not comprehensive but is a representative sampling of materials used on U.S. Coast Guard ships. The user may select from the provided list of barrier materials the one most like the actual barrier used on the ship being analyzed. Or, the user may add a new barrier material to the list if all the material's heat transfer data and Tbar and Dbar curves are known.

C.5.1.1. View/Print Barrier Material Values

This options allows the printing of the values assigned for each barrier material type provided with SAFE, as well as any new materials added by the user.

C.5.1.2. Add New Materials to Database

This option accesses a screen which displays the barrier materials currently in the database, with those designated as 'Structural' listed before the 'Non-Structural'. Non-Structural materials may not be used for exterior barriers or watertight bulkheads.
Two lines of information are provided for each current material.
1: structural/non-structural Use, unique material ID, and Description.
(Only the Use and Description may be changed, NOT the unique material ID.)
2: thickness, density, specific heat, thermal conductivity, heat release, Tbar and Dbar curves.
(None of these may be changed.)

The user is not allowed to change the unique material ID or the material's properties so that if a previously analyzed ship is restored, the properties associated with a given material ID will not change allowing new model runs to be fairly compared with previous runs.

To add a new material, position the cursor anywhere within the list of materials and press <F3> to insert a new row. Follow the on-screen instructions for entering the necessary information. Note that the ID must be a unique 1-4 characters. For ease in remembering the ID, the code should be "built" with character 1 reflecting its material, character 2 expressing its thickness in eighths of inches, and character 3 indicating whether it is insulated or uninsulated. Thus the ID 'A2I' represents Aluminum, 2/8" thick, Insulated and 'S5U' represents Steel, 5/8", Uninsulated. Note that for SAFE's Nomex honeycomb core materials, character 2 is used to indicate the facing material (Plastic or Stainless steel) rather than the thickness.

If the information for a material being added is similar to a previous one, inserting the new row after the old material will allow easy comparing of similar information. This is particularly useful if the user wishes to adjust the Tbar and Dbar curves of a current material by adding a 'new' material with all properties being the same except for the Tbar/Dbar curves and the unique material ID. In such a case, it is recommended that the ID be the same as the original material with a fourth digit added to make it unique, e.g. if the ID for the original material is 'A2I', then make the new ID 'A2I1' for the first adjustment to 'A2I'.

Be sure to review carefully all the information entered for the new material before pressing <esc> to save it. Once the information is saved, only the Use and Description may be changed. After each new material is added, the screen will redisplay to allow review of existing materials or entry of another new material.

C.5.2. Assign Barrier Materials...

When this option is selected, a hierarchy of assignments appears beginning with the general "Assign Overall Ship Defaults" and going to the more specific "Adjust Overhead Materials by Compartment". Four separate barrier material assignment options, some required and some optional, are discussed in detail in the following subsections. Each option will display an entry screen which allows assignment of a subset of barrier material assignments. When this section is completed, each barrier on the ship will have been assigned a material ID by default. These defaults may be tailored individually in AutoCAD (Section C.5.3.)

C.5.2.1. Assign Overall Ship Defaults (Required)

The screen which appears when this option is selected allows the entry of the following:

- **Overall Barrier Derating Factors** - Enter the values for thermal and durability derating recorded on the Ship Data Form to be applied to all barriers on the ship. In Section C.5.3 these default adjustments may be tailored for individual barriers. Leaving the adjustment at 0 assumes a like-new condition. The maximum adjustment of the entire ship's barrier strength is -30%. (Individual barriers may be adjusted up to -99%.)

- **Exterior Barrier Material ID's** - Enter the IDs recorded on the Ship Data Form for hull and superstructure weather bulkheads and overheads.

- **Interior Material ID's** - Enter the IDs recorded on the Ship Data Form for the predominant material used throughout the ship for bulkheads and for overheads.

- **Watertight Material ID** - Enter the ID recorded on the Ship Data Form for the primary material used for watertight bulkheads.

NOTE: The ship's proper name, number and the plan date may also be entered or adjusted at this time, if necessary. When material assignments are complete, press **<esc>** to record entries made and return to the calling menu.

C.5.2.2. Adjust Interior Materials by CUI (Optional)

This option allows default assignment of compartment interior bulkhead and overhead material ID's by CUI, as recorded on the Ship Data Form. If the user elected not to complete the "Barrier Material ID assignments by CUI" portion of the Ship Data Form, this option may be skipped. For ease of use, the default materials for the entire ship have been assigned to all CUI's so that only the exceptions need be entered. These default materials may be tailored for each individual compartment overhead in Section C.5.2.4 and for each and every barrier in Section C.5.3 to reflect the data on the barrier data plots.

TO ASSIGN THE DEFAULTS BY CUI:

Either type in the desired barrier material ID or utilize the function keys to display available IDs as described below:

With the cursor in the Bulkhead column next to the first CUI needing modification, press **<F6>** to list available interior bulkhead materials, scroll using the arrow keys to see all selections, and place the cursor on the predominant one for compartments with this CUI. Press **<esc>** to assign the material. Then with the cursor in the Overhead column, press **<F8>** to list the available interior overhead materials, again positioning the cursor on the predominant one, and press **<esc>** to select it.

NOTE: If interior barrier materials defaults for compartments within the superstructure differ from the interior barrier material for compartments within the hull, enter the HULL interior barrier materials on this screen. The interior barrier material defaults for compartments within the superstructure will be assigned in the next section.

When default assignments by CUI are complete, press **<esc>** to record them and return to the calling menu.

C.5.2.3. Adjust for Superstructure by CUI (Optional)

This option is useful if the previous section was completed and if default interior barrier materials for compartments within the superstructure differ from those within the hull. It may also be useful even if the previous section wasn't completed in order to adjust barrier materials by CUI for the superstructure only. If this option is chosen, the CUI's which are found in the superstructure and their default material assignments previously made are displayed. Individual adjustments may be made for each CUI either by typing the barrier material's ID or by using the same function keys mentioned in Section C.5.2.2. Scroll through the materials list using the arrow keys.

When default assignments by CUI are complete, press <**esc**> to record them and return to the calling menu.

C.5.2.4. Adjust Overhead Materials by Compartment (Optional)

This option allows for tailoring of a compartment's overhead materials. It need be selected only if the materials assigned either for the entire ship in Section C.5.2.1 or by CUI in Sections C.5.2.2-3 are not accurate for all compartments. If selected, a screen appears listing all compartments. The default values were assigned to each compartment's overheads, and only exceptions need to be entered. Type over the default for the compartment where the exception applies, or press <**F8**> to list the available interior overhead materials, placing the cursor on the predominant one and pressing <**esc**> to assign it.

When all adjustments to overhead materials for each compartment have been made, press <**esc**> to record them and return to the calling menu.

C.5.2.5. View/Print Current Values Assigned Above

This option will prepare a report to view or print the hierarchy of barrier material values assigned from the Overall Ship Defaults through the Adjustments by CUI and finally to the Overhead assignments for each compartment.

C.5.2.6. DONE: Prepare for Barrier Tailoring (Required)

This option requires no user input unless incomplete barrier material values are found. If so, the user is returned to the "Barrier Material" menu in order to fill any blanks which may have inadvertently been placed in any of the entry screens called by this menu.

If barrier values are complete, the following message appears: "Assigning barrier materials for tailoring in AutoCAD". This section may take several minutes to be completed; press no keys until prompted.

The "Assign Barrier Materials" section is now complete. Select "Return to Previous Menu" to return to the "Assign & Tailor Barrier Values" menu.

C.5.3. Enter Openings/Tailor Barriers in AutoCAD

This option appears on the "Assign & Tailor Barriers" Menu and may be done over several sessions until all tailoring is finished. When this option is selected, SHIP.DWG will be opened.

The first time this option is selected, watertight bulkheads are plotted on the s-layers in **yellow**. "Stepped" bulkheads created by variations in elevation along a deck are plotted in **white** if they connect two compartments on different decks, or **cyan** if they connect a compartment with the exterior of the ship. These "stepped bulkheads" are plotted on the lower deck of the two decks they join and are described in more detail in Section C.5.3.1's Bulkhead Tailoring Notes. Both watertights and stepped bulkheads are color-coded to provide a visual reminder during bulkhead tailoring.

Next, on each s-layer in order, small white bulkhead blocks will be drawn at the midpoints of interior and exterior bulkheads.

Then on each o-layer in order, small white overhead blocks will be drawn within each overhead. These o-layers (NOT 0-layers!) were used in Section III.F.2 to insert hatch blocks and correspond to the s-layers. (The overheads of layer s-1 are plotted on layer o-1.)

Barrier information from the database is contained in the blocks and can be edited, and exceptions and openings that were noted on the barrier data plots can be entered.

The **MULTIPLE DDATTE** command will be used to edit the blocks. The **MULTIPLE** option repeats the **DDATTE** command, allowing repeated block selection and editing until cancelled by pressing **<ctrl-c>**. Refer to the *AutoCAD Reference Manual* for more information on the **DDATTE** command and attribute dialogue boxes. **'ZOOM** and **'PAN** (transparent) can be used to move around the layer while within the **DDATTE** command.

This is the "tailoring" process. Read the remainder of this section, before beginning tailoring.

GENERAL TAILORING NOTES:

- DO NOT MOVE THE BLOCK SYMBOLS. Doing so DOES NOT change the bulkhead associated with that block symbol in the database. The location of that block symbol as stored in the database will not change. Moving the block symbol to a different compartment or bulkhead will result in unresolvable errors later on. Moving the symbols along the barrier is also prohibited, as it will prevent the SAFE utilities from updating the blocks to match any database changes later on.
- If a barrier connects two compartments, both of which are not considered in the analysis, the barrier does not need to be tailored.
- Even though door and hatch blocks may have been **INSERT**ed into SHIP.DWG, the actual information about number of doors or hatches of each type and damage control condition must now be entered in the barrier block where they exist in order to be recorded in the database and be accounted for by the model. In fact, if a door or hatch block was mis-located, it may be moved to the correct location, but moving it will have no effect on the barrier block in which it was entered.

GENERAL PROCEDURE FOR TAILORING:

DI layer s-1, then **ZOOM EXTENTS**. **ZOOM DYNAMIC** around a section beginning at the bow. The section should roughly resemble the section plotted for the barrier data plots used at the ship visit. Enter the **MULTIPLE DDATTE** command. Starting at the bow of the s-1 layer, one by one, select any bulkhead blocks which require tailoring, paying special attention to barriers along reduced-height and stepped bulkheads. A barrier block for a reduced-height or stepped bulkhead will be offset from its midpoint. Ensure that all barrier materials, T and D adjustments, and doors have been entered to match the values from the barrier data plots. It will be helpful to mark each bulkhead on the barrier data plots as its tailoring is completed.

When the bulkheads in a particular section have been tailored, **<ctrl-c>** to exit the command and use the **D3** command to turn on layers o-1, b-1, and b-2 so that overheads for the s-1 layer may be tailored.

Rather than the b-layers, it is also possible to turn on the s-layers with the o-layer. The result may be confusing due to the multitude of text, polylines, and barrier blocks that are displayed making the overhead blocks drawn on the o-layers difficult to see. However, in some cases this may be necessary to enable the plan ID to be displayed.

Again use the **MULTIPLE DDATTE** command to access overhead blocks that need tailoring. Ensure that all overhead materials, T and D adjustments, and hatches have been entered to match the values from the barrier data plots. Hatch blocks should serve as a reminder to the user to enter a hatch in an overhead, but additional hatches may have been drawn in the barrier data plots during the ship visit and should also be recorded. If additional hatches are drawn, they may be **INSERT**ed as hatch blocks on the o-layer at this time so that the appearance of the drawing is correct, but their addition to the drawing doesn't replace the need to record the hatch and its type in the overhead block.

When a particular section has been completely tailored (s-layer and o-layer), use **<ctrl-c>** to exit the command and **ZOOM** to the next section, working to the stern of the ship. Then **D1** to the s-layer and continue tailoring. When the tailoring of the s-1 layer bulkhead blocks and o-layer overhead blocks is complete, enter **<ctrl-c>** to exit the editing command and **D1** layer s-2. **ZOOM EXTENTS**, **ZOOM DYNAMIC** around the bow, and issue **MULTIPLE DDATTE** again.

Repeat the tailoring process for the s-2 and o-2 layers and all other s- and o-layers.
Tailoring can be completed over many editing sessions. It is recommended to proceed in a logical manner, recording each stopping place on the data forms or barrier data plots.
Be sure to SAVE the drawing frequently.
To reenter SHIP.DWG to continue tailoring: from SAFE MAIN MENU select:

    "b. Load Database with Ship Data"
        "b. Enter Compartment/Barrier Data"
            "d. Assign & Tailor Barrier Values"
                "c. Enter Openings/Tailor Barriers in AutoCAD"

When ALL tailoring is finished, the tailored barrier information will be extracted and used to update the SAFE database.

C.5.3.1. Tailor Bulkhead Values and Assign Doors on s-layers

Only bulkhead barrier blocks with changes to be made to default assignments or with doors to be entered need to be edited. Barrier blocks with neither of these can be skipped during editing.

The barrier material ID's listed in each barrier block are crucial to SAFE since barriers are the major component of passive fire protection. Each bulkhead is currently assigned two or three material ID's. Interior bulkheads have one material assigned to each side of the barrier and a third material if the barrier is along a watertight bulkhead. Exterior bulkheads have one assignment for the exterior side of the barrier and one for the interior side. The materials initially assigned to each barrier block are the defaults assigned in Section C.5.2.

The values used by the probabilistic model for each barrier will be a composite of the values associated with all the material ID's assigned to that barrier. It is important during this portion of tailoring to ensure that the material ID's in the barrier blocks accurately reflect the data recorded on the barrier data plots.

The interior materials shown in each block are assumed to be facing materials on exterior or watertight bulkheads. If a barrier along a watertight or exterior bulkhead has NO facing material, the material ID for that side of the barrier must be changed from the default assignment to be the same as the watertight/exterior material ID to, in effect, "remove" that facing material. If the facing material is not "removed" during tailoring, that facing material will be mistakenly included in the fire growth calculations for that barrier when the probabilistic model is run. (See Appendix L for a discussion of the effect of assigning the same material ID more than once to a bulkhead.) This is also the time to change barrier material assignments to zero-strength ("000") for all zero-strength bulkheads noted on the AutoCAD Worksheet, part 6. Be sure to change both barrier materials in the block to "000".

In general, changes to the exterior materials should not be made for individual bulkheads since the hull or superstructure is usually constructed of all one material. An exception to this occurs in the case of icebreakers when the bow material may be thicker than the rest of the hull. Another exception occurs when a portion of the hull is insulated. These bulkheads should be changed in tailoring.

The following parameters may be altered and assigned in the bulkhead blocks:

- **Interior Barrier Material** defaults assigned in Section C.5.2 for each side of the bulkhead may be edited here. Be sure to edit the correct "side" of the bulkhead. Refer to the plan ID's in the adjoining compartments to determine which side of the bulkhead is #1 or #2. Refer to the barrier data plots to ensure that facing materials on watertight/exterior barriers are tailored correctly. If a bulkhead is zero-strength, assign '000' to both sides. Refer to Appendix A for a listing of SAFE-provided barrier materials. If the bulkhead is made of only one material, then the two (or three) materials assigned to it should all be given the same barrier material. For example, if a watertight bulkhead is made of 3/8" structural steel and has no facing materials, then its AutoCAD block must have the ID for 3/8" structural steel entered three times for that bulkhead.

- **T and D adjustment** values which were assigned to the entire ship (0 to -30%) have been assigned to each barrier as the default, and may be edited to match the values on the barrier data plots. The allowable range of these values for individual barriers is from -99 (in poor condition) to 0 (like-new). This reflects the percent by which the barrier's thermal (T adjustment) and durability (D adjustment) strength should be derated. If a barrier has a weak spot causing it to be less fire resistant than the default set for the entire ship, tailor its T adjustment or D adjustment value to be closer to -99. A common example of a weakened barrier is the louvered vent in a closed joiner door. Conversely, if a barrier has been upgraded so that it is in better condition than the overall ship, tailor its default derated value to be closer to 0. Note that there is only one T and D adjustment for each barrier, not one for each side of the barrier.

- **Door types** available on the ship are listed in the barrier block with a default of 0 doors of each type. To enter doors in a barrier, enter the number of doors of that type which exist in that particular barrier ONLY. Bolted access plates are ignored.

BULKHEAD TAILORING NOTES:

- A barrier added through a reduced-height exception will have a second barrier block offset from the barrier block at the midpoint of the original barrier. Check the plan ID's of the compartments connected by each barrier to ensure the correct barrier is being tailored.

- Barriers added through a stepped deck appear on the lower s-layer of the two compartments they connect, on a white (interior) or cyan (exterior) line offset from the original compartment polyline. Again, check the plan ID's of the compartments connected by each barrier to ensure the correct barrier is being tailored. Two types of exterior barriers can be created by a stepped deck; one appears above the main deck and one extends downward within the hull. The exterior step barriers above the main deck are assigned the superstructure material as their exterior material. They appear as cyan lines offset to the right of the compartment polyline. The exterior step barriers extending downward within the hull are not assigned an exterior material and are not plotted. (see Figure III-6b, types b. and c.).

C.5.3.2. Tailor Overhead Values and Assign Hatches on o-layers

Only overhead barrier blocks with hatches, T or D adjustment value changes, or changes to the overhead material assignment which were noted on the barrier data plots completed at the ship visit need to be edited.

An overhead barrier is the area of overlap between the overhead of a compartment and the deck of a compartment above it. Thus, a compartment's overhead may contain several overhead barriers. Each overhead should contain one block which may be tailored if necessary. The only exception to this exists if a compartment has multiple weather overheads. In that case only one block will be drawn to represent all of them. Any material ID adjustments, barrier derating, or hatch entry for all of that compartment's weather overheads must be done in the one overhead barrier block.

As discussed in Section C.3.4.2, each overhead connection (to another compartment or to the weather) is assigned only one material, unlike bulkheads which may have up to three barrier material assignments. The original default material ID assigned all overheads on the ship may not be the material of all overhead barriers in a compartment. The correct material may be assigned to that specific overhead barrier on the appropriate o-layer. The overall ship's thermal and durability adjustment may be tailored here for individual overheads, and hatches should be entered in the correct overhead.

The following parameters may be altered and assigned in the overhead blocks:

- **Barrier Material** defaults assigned to each compartment's overhead in Section C.5.2.4 may be edited here. Exceptions to the assignments should be made on the individual portions of a compartment's overhead which connect it to different compartments' decks above. Pay particular attention to make sure 0-strength overheads are assigned a '000' (as between the Engine Room and its uptake.)

- **T and D adjustment** values which were assigned to the entire ship have been assigned to each overhead as the default (0 to -30%) and may be edited to match the exceptions noted on the barrier data plots (0 to -99%).

- **Hatch types** available on the ship are listed in the block's dialogue box with a default of 0 hatches of each type. To enter hatches which were recorded on the barrier data plots, enter the number of hatches of that type which exist in that particular overhead only. Bolted access plates are not included.

Be sure to **SAVE** the drawing when finished tailoring.

C.5.3.3. Extract Reports

When all blocks are tailored completely, the block information must be **EXTRACTed** into files for loading into the database. Enter **EXTRACTS** at the **Command:** prompt to call the SAFE **EXTRACTS** utility (see Appendix M). This utility uses the **ATTEXT** command to generate a file that contains the current tailored information in the barrier blocks and automatically checks the tailored values. NO additional user input is required.

Once the value-checking process is complete, a screen indicates the status of the 'EXTRACT' files. There are three possible outcomes for this process:

i. If no values are missing and all values are valid but NO CHANGES were made, the user is so informed.

ii. If no values are missing and all values are valid and CHANGES were made, the user may view/print a report of the CHANGES. The user is then informed that the database will load automatically when AutoCAD is exited. If the report of the CHANGES shows more tailoring to be done, the user may make the additional changes and do another '**EXTRACTS**'.

iii. If there are missing or invalid values, an error file is created pinpointing the blocks with errors, which the user may View/Print. The database will not load ANY values until all errors are corrected in the barrier blocks in SHIP.DWG and '**EXTRACTS**' is repeated.

When finished, **END** the drawing and exit AutoCAD. If extract files exist, the process of loading these tailored barrier values into the database will begin immediately. If no extract files exist, the user is warned and allowed to re-enter AutoCAD and create them or to Xit SAFE and return at another time to complete tailoring.

NOTE: Do not abandon the "Enter Openings/Tailor Barriers in AutoCAD" until the database is completely loaded with correct parameter values. Without these values loaded in the database, the probabilistic model cannot be run. To continue this process, choose "Enter Openings/Tailor Barriers in AutoCAD" from the "Assign & Tailor Barrier Values" menu. If the option to "Calculate FRI / Modify FRI-critical Values" is chosen before this process is complete, SAFE will automatically return to this section to complete it before continuing.
When the database is loaded, the "Assign & Tailor Barrier Values" menu will reappear.

C.5.4. View/Print Current Barrier Values

This option reports all values assigned to individual barriers for each compartment. Included for each barrier are the adjoining compartment's name and Plan ID, up to three barrier material ID's, the barrier's area, thermal and durability derating, and number of openings, opening types, and damage control condition. This report is lengthy and fairly slow to produce. In addition, SAFE provides another version of this report suitable for importing into an electronic spreadsheet, 'm_bars.ss', which may be found in \SAFE*code*\SS.

The "Assign & Tailor Barrier Values" section is now complete. Select "Return to Previous Menu" twice to return to "Load Database with Ship Data" and proceed with FRI and Post-FRI Heat Release Calculations.

D. CALCULATE/REVIEW FRI AND POST-FRI HEAT RELEASE RATES...

This option appears on the "Load Database with Ship Data" menu.

When this option is selected, all compartments to be analyzed are checked to ensure that all values necessary to calculate FRI have been entered and that an access in the form of a door, hatch, or zero-strength barrier exists in every compartment being analyzed.

If any non-accessible compartments are found, a warning screen with a menu appears. The user may view/print a list of compartments with NO openings, add overlooked doors and hatches through AutoCAD tailoring, or indicate that an access is unnecessary for the compartment(s) in question. This last case will occur for spaces accessible only through bolted access plates. When the option to continue is selected, the check for access is performed again until all compartments either have an access or are flagged as not pertinent.

Once this process is complete, FRI time and Post-FRI heat release rates are calculated.Then the user is presented with a menu allowing the FRI time results to be viewed and adjusted, the results to be viewed/printed, the A & M values to be reviewed and completed if necessary, and their values to be viewed/printed. The menu presented varies depending upon whether or not this is the first time that FRI has been calculated. If FRI data changed as a result of changes to the data set, the user is given the option of viewing or printing a report that lists the changes. If no change in the FRI input data has been made since the latest FRI calculation, FRI is not recalculated and the user is told that the menu reflects the previous FRI calculation.

D.1. Review/Adjust Calculated FRI Time Values

When this option is selected, a screen will appear displaying the calculated FRI time values for each compartment being analyzed. FRI time for each of the readiness conditions (XRAY, YOKE, ZEBRA) was deterministically calculated utilizing the Beyler/Peatross algorithm. See Chapter 6.1.2. and Appendix B of the *Theoretical Basis* for details of this algorithm. This algorithm is not necessarily a good predictor of FRI time for irregularly-shaped compartments. Those compartments are flagged by one or two asterisks to the left of the compartment's plan ID. An asterisk in the far left column of the screen indicates that the compartment has a potentially irregular geometry defined as having in excess of 6 horizontal plane vertices or a length to width (or width to length) ratio in excess of 4. If a compartment has a zero-strength barrier, an asterisk appears in the second column.

The FRI time calculated for all compartments should be reviewed, but special attention should be given to compartments flagged by one or two asterisks. If the FRI time seems unreasonable for any compartment, two alternatives are available to the user:

1. The times may be adjusted by entering alternate times in the "ADJUSTED" columns on the right of the screen. Note that for most compartments, FRI time calculated using the Beyler/Peatross algorithm doesn't change with the different door/hatch status possible in condition XRAY, YOKE, or ZEBRA. If the user chooses to enter adjusted FRI values, they should be carefully determined, either by utilizing an alternate FRI time prediction model outside of SAFE or using fire-protection engineering experience and judgment. The three components of fuel load (cellulosics in psf, plastics in psf, and total gallons of flammable liquid) are converted into kBTU's/ft^2 for the FRI calculation, and the fuel remaining after FRI is reached is passed on to the probabilistic model. Both the initial fuel load and the post-FRI fuel load are listed on the screen.

   If FRI time is adjusted, the corresponding post-FRI fuel load may also need to be adjusted. If the user chooses to adjust FRI times or post-FRI fuel load for specific compartments, the adjusted values are used by the probabilistic model for those compartments. If compartment or barrier data is altered later and FRI is recalculated, these adjusted values are not overwritten, but should be re-evaluated and re-adjusted if appropriate to reflect the data changes.

2. The input data (compartment fire growth models, fuel loads, ventilation or barrier materials or openings) may be reconsidered and adjusted and FRI will be recalculated. To do this, this screen must be exited by pressing <esc> and the user must return to previous menus until the "Enter Compartment/Barrier Data" is presented. Select the compartment or barrier submenu from "Enter Compartment/Barrier Data". After the changes have been made to questionable compartments and/or their barriers through the appropriate screen or in AutoCAD, FRI must be recalculated. Any changes which result will cause a new menu choice to be displayed on the "Calculate/Review FRI and Post-FRI Heat Release Rates" menu allowing the user to view/print a list of changes in the CALCULATED FRI values.

A FRI time of 999 indicates that the compartment will not reach full-room involvement using the Beyler/Peatross algorithm. This may be due either to depletion of available fuel before FRI is reached or to the fire growth model chosen. When the cursor is in the row of a compartment with a 999 FRI time, a comment at the bottom of the screen will indicate which of the two factors, fuel load depletion or fire growth model chosen, prevented FRI from being reached. If the 999 FRI time seems unreasonable for a given compartment, the user may adjust FRI on this screen (see alternative 1 above). OR FRI may be recalculated after either increasing the fuel load if the comment indicates fuel load depletion or selecting another fire growth model if the model chosen is the limiting factor (alternative 2 above). If a different fire growth model is selected, the stack height and % area occupied should be reviewed as well. Refer to Appendix D of this manual or Appendix C of the *Theoretical Basis*.

It should be noted that the FRI time calculator in SAFE does not actually allow 999 minutes for a compartment to reach FRI. In fact, a compartment is given 99 minutes in which to reach FRI. Fuel is subtracted from a compartment's fuel load each minute of the calculation until either FRI time is reached, the fuel is depleted, or until 99 minutes have passed. Thus the post-FRI fuel load listed for compartments which fail to reach FRI is either 0 or is a result of 99 minutes of depletion.

In addition to FRI times and Post-FRI fuel load, the screen displays for each compartment its Post-FRI Heat Release rate for conditions XRAY, YOKE, and ZEBRA, the initial fuel load components of cellulosics, plastics and flammable liquids assigned by the user, Alpha (pre-FRI fire growth rate in kW/sec^2) and Qmax (maximum heat release rate a fire in a given compartment is allowed to reach in kW).

Note that Post-FRI Heat Release rate is a function of ventilation up to the point when Qmax is reached. At that point, Qmax is assigned as the Post-FRI heat release rate for all damage control conditions until all fuel is depleted. See *Theoretical Basis* Chapter 6.3.4.1 for details.

WHEN THE FRI TIMES AS SHOWN OR ADJUSTED ARE ACCEPTABLE: Press <esc> to return to the "Calculate/Review FRI and Post-FRI Heat Release Rates" menu.

D.2. View/Print FRI Times and Heat Release Rates

This option creates a report which may be viewed/printed. It is recommended that this report be printed when FRI times for the baseline are established to keep for future reference.

D.3. Review/Complete A & M Values

This option allows the user to review A and M values assigned to each compartment now that the compartment's FRI times are considered realistic. These values MUST be complete before the probabilistic model can be run.

Both A (the probability that a fire will be extinguished using fixed fire protection systems before FRI is reached given that it did not self-terminate)

and M (the probability that a fire will be extinguished manually before FRI is reached given that it did not self-terminate and was not extinguished using fixed fire protection systems)

may be affected by the user's newly-attained knowledge of FRI time.

The screen displays not only A and M values, but also FRI time in readiness condition XRAY. When all adjustments to A and M values are complete, press <esc> to save the entries and return to the "Calculate/Review FRI and Post-FRI Heat Release Rates" menu.

D.4. View/Print A & M Values

This option creates a report with A & M values and FRI time in readiness condition XRAY.

This section is now completed. Selecting "Return to Previous Menu" will return to the "Load Database with Ship Data" menu.

E. VIEW/PRINT REPORTS AND FORMS

This option appears on the "Load Database with Ship Data" menu.

At this point, the database is loaded with an accurate picture of the ship's geometry and valid fire parameter values. These parameters may be examined by generating up-to-date database reports. See Chapter VI for a description of all database reports available. This is the final opportunity to review the contents of the database and ensure it accurately reflects the ship before running the probabilistic model. Note that some of the reports mentioned in Chapter VI are not available until after "Run Probabilistic Model" is executed.

The reports described in Section VI.E, "Compartment Fire Parameter Reports", provide a good summary of all assigned compartment values. It is recommended that these reports be printed and reviewed for consistency and accuracy of assignments before the model is run.

Changes CANNOT be made at this point to deck, compartment, or barrier geometry without beginning again as if for a new ship (which includes creating new ".DXF" files in AutoCAD and loading them into the database).

Changes may be made at this point to:

- Ship Information — Section B
  (Proper Name, Ship's Plan Date, or Deck Names)
- Compartment Plan IDs, Names, CUIs — Section C.2
  (If changes are made to CUIs, values assigned in Sections C.4 and C.5 must be reviewed.)
- Compartment Information — Section C.4
  (FSOs, % Time Monitored, Fuel Load, I, A, M, Ventilation, Fire Growth Models, Detection and Suppression Systems)
- Barrier Information — Section C.5.3
  (Materials, Openings, or Derating Factors)

If any changes made affect Full Room Involvement calculations or Post-FRI Heat Release Rates, they will automatically be recalculated before the user is allowed to proceed with "Run Probabilistic Model." When satisfied with all values assigned, return to the SAFE Main Menu. The database is now ready to continue with Chapter V, "Run Probabilistic Model".

Chapter V. RUN PROBABILISTIC MODEL

This option appears on the "SAFE Main Menu".

A. CHAPTER OVERVIEW

Now that all of the required data has been entered into the database, the probabilistic fire model may be run on this data set. A run of the fire model begins with established burning (EB) at time 0 (minutes) in one compartment (referred to as the room of origin). The fire is allowed to progress through time to a user-specified end time. Results may show the frequency of involvement of a compartment or set of compartments, or possible paths of fire propagation. The user must specify certain conditions (the "scenario") for each model run. After the model has been run and the results examined, a new scenario may be prepared for another model run.

During a model run, after full room involvement (FRI) in the room of origin has been reached, the probabilistic model calculates the quantity of heat energy attacking each barrier minute by minute until the barrier is destroyed (Dbar=1). The heat energy impact is compared to the fire resistance of the barrier, and the probability of barrier failure is determined (either Tbar or Dbar failure). If the failure criteria of a barrier has been met, the model starts EB in the adjoining compartment.

In this space-barrier propagation, the probabilistic model builds a set of paths of fire spread. As the model run progresses, more and more compartments may become involved in the fire, producing more paths. The number of paths of fire spread grows exponentially over time. When the model run reaches the user-specified termination time, the values of variables describing the probable extent of the fire for each path are calculated and provided.

After a number of model runs have been completed with various scenarios, the user should examine the results to determine how, and if, the overall fire safety of the ship could be improved. Then the data set (compartment, barrier, and FRI data loaded into the database in Chapter IV) can be altered to see the overall effect on the probabilistic model. The altered data set may be saved to create a new data set.

Once the "Run Probabilistic Model" option is chosen from the Main Menu, all opportunities to change the data set will be handled from the "Run Probabilistic Model" selection whose

menus and submenus are discussed in this chapter. Do not return to the Main Menu to make changes. The "View/Print Reports and Forms" option from the Main Menu, however, MAY be used to examine modeling and database reports, although modeling results are also available in this section.

The "Run Probabilistic Model" menu predominates for the remainder of a ship's analysis. Options presented on this menu as described in this chapter may be repeated until the analysis of the current ship is complete. This menu is a dynamic one because the options which it presents vary depending on the status of the analysis. All options are presented in this chapter in the order in which they will appear on the "Run Probabilistic Model" menu, but some of these options will be present only when they are available for selection. For example, the first time the user selects "Run Probabilistic Model" from the "SAFE Main Menu", the option to "Undo Modifications to the Data Set" or "Choose a Previously Saved Data Set" will not be available because no modifications have been done and no data sets have been previously stored.

In order to understand how SAFE controls modifications to the ship made by the user, it is necessary to understand the "data set" concept. A data set consists of the ship-specific compartment and barrier fire parameter information in the database at a given time, along with the matching SHIP.DWG. The data set whose values are currently in the database is referred to as the current data set.

The following functions, described in this chapter, may be performed on a data set:

Examine modeling results on any data set	(Section B)
Save the current data set	(Section C)
Modify the current data set	(Section E)
Undo modifications to the data set	(Section D)
Choose a previously saved data set	(Section F)
Clean up previously saved data sets and associated model runs	(Section G)
Specify scenario for another model run using the current data set	(Section H)

For example, assume the baseline data set for a ship was established using the procedures described in Chapters 3 and 4. When "Run Probabilistic Model" is selected from the "SAFE Main Menu", this data set will be referred to as Data Set 1 by SAFE. Assume the model is run using this data set. Each model run is numbered sequentially and its results (not the data set itself) are stored under a subdirectory for this ship named Set-1.

If the user is satisfied that Data Set 1 is, indeed, the ship's baseline, it is a good idea to save Data Set 1 (See Section C) before modifying it to test an alternative. On the other hand, if more modifications to Data Set 1 are in order to make it the baseline, there is no need to save it. If the user wishes to modify the data set either to test an alternative or to define the baseline further, then the option to modify the data set is selected, and Data Set 1 is set aside (reserved) and retains its data set number.

After the user modifies some aspect of the data set as described in Section E, the modified version becomes the "current data set". If the user chooses to print a report using this modified data set before running another model, the user will be prompted as to whether or not to print "mod" after the data set number at the top of the report. This is necessary to indicate that the report may contain information that was not used to produce the model results previously stored under that data set number.

Then when a model run is made using this modified version, its data set number is incremented by 1 (to become Data Set 2 in this case). The modeling results, numbered sequentially, are saved under a ship subdirectory named \SAFE*code*\Set-2.

The user may choose to undo the modifications made (Section D) which will cause the reserved data set (Data Set 1) to become the current data set again.

Instead of undoing the modifications, the user may further modify the data set (Section E) and run the model again making a new current Data Set 3 (Section H) and a Set-3 subdirectory storing the results of Data Set 3. (\SAFE*code*\Set-3)

This current data set may be "saved", which stores the database information along with SHIP.DWG in the Set-3 sub-directory. Now that this current data set, Date Set 3, has been saved, it will be the data set being reserved if modifications are made and the newly modified data set will be Data Set 4. Data Set 1 will no longer be restorable if it wasn't "saved" by the user. Only when the user selects to save the current data set will the set actually be set aside and stored in a state which may be restored if the user wishes, by choosing a previously saved data set (Section F).

If too many data sets are stored or too many model runs are done, disk space may become a problem and the user may wish to clean up previously saved data sets and associated model runs (Section G). SAFE allows a maximum of 100 data sets and 500 model runs to be saved.

Note that only one data set at a time may be the "reserved" data set which may be restored to become the current data set by selecting "Undo modifications". Until the option to save the current data set is selected, Data Set 1 is the "reserved" data set, even if it has never been "saved" by the user. After that, the most recently saved data set becomes the "reserved" set.

B. EXAMINE PRIOR MODELING RESULTS

This option is offered only after a model run has been completed. Two choices are presented:

B.1. Index of ALL Model Runs

This option will produce a report which lists each data set's number, user-input comments about the data set, and the associated scenarios run using that data set. This report, which may be viewed on the screen or printed, provides a handy summary of the status of the ship's analysis.

B.2. Selected Model Runs

When this option is selected, a screen appears where all model runs not previously deleted will be listed in the order in which they were run, the most recent first. Enter a **P** next to the run results to be viewed or printed, and/or a **D** next to the model run results to be deleted. When all results of interest have been marked, press **<esc>** to continue or **<ctrl-c>** to cancel out of the screen. For a model run with the I (Individual Compartment Targets) option, if a graphic report is desired, note that only one run may be chosen at a time since AutoCAD must be entered to produce the graphic report.

The model run results which have been marked for deletion, if any, will be deleted. If run results were selected to print, a message naming the first results to be examined will appear. Press **<enter>** to display the Modeling Results menu, then select the type of report (summary, detail, or graphic) to examine. Only the type of reports created by the output option selected for that run will be available (listed below). A more detailed discussion of each report is given in Section VI.G. When the results have been reviewed, select "Return to Previous Menu" until the message naming the next results to be examined appears. The process will repeat until all selected results have been examined. When all selected results have been reviewed, the "Model Run Complete" menu will reappear.

P: Paths. A SUMMARY LISTING of the paths with the Cumulative L value of the final compartment in the path and a DETAILED ANALYSIS of each path are available.

I: Individual Compartment Targets. A SUMMARY LISTING of the targets, ordered by their Relative Loss Factor (RLF), and a DETAILED LISTING of the paths formed in all fires which involve the target's loss are provided. A GRAPHIC REPORT of all target compartments colored and hatched by relative loss factor is also available.

In addition, SAFE provides a file listing the targets and their RLF in a format that may be imported into an electronic spreadsheet. This file is not available on the reports menu but may be found in the directory \SAFE*code*\SS where *code* is the 3-4 digit code for the ship. In this directory is a file, 'compname.ss', with all analyzed compartments listed by CUI with their names and plan IDs. Also in the directory is a file, 's.run#', for each model run that used the I option with the same compartments listed in the same order with their plan IDs and RLF. The two lines at the beginning of each file may be used as headings for the spreadsheet columns.

S: Target Sets of Compartments. A SUMMARY LISTING of the target sets ordered by their relative frequency of loss, and a DETAILED LISTING of the paths formed in all fires which involve the compartments in the target sets are available.

B: Barriers. A SUMMARY LISTING of the compartments as rooms of origin and their associated barriers which failed in the given model run time. The rooms of origin are ordered from bottom to top, fore to aft, and barriers within each compartment are ordered by the probability of loss given Established Burning (EB). A DETAILED LISTING of all barriers is also provided, first ordered by the probability of failure given Established Burning (EB) and then ordered by the relative frequency of failure given Fire Free State (FFS). However, this detailed report is no more detailed than the summary report. It lists all barriers while the summary report lists rooms of origin and their associated barriers. Essentially the same information is listed on both, but the ordering is different.

R: Critical Run Time. Only a SUMMARY LISTING of the RLF's for each target at 10 minute intervals up to 60 minutes is provided.

C. SAVE THE CURRENT DATA SET

Saving the current data set is offered after a model run has been completed which utilizes it, unless the current data set has just been saved.

This option to "Save the Current Data Set" appears on the "Run Probabilistic Model" menu. While all modeling results associated with a data set are automatically saved to disk whenever the model is run (until the user selects to have them deleted as described in Section B.2 or Section G), the data set is only saved if the user chooses to do so.

The first goal in the modeling process is to establish the baseline data set. This baseline data set is intended to represent the ship in its current state in all respects, and is considered the standard against which alternatives for improvements in fire protection for the ship are judged. If confidence in the values assigned and tailored in Chapter IV is high, then Data Set 1 as it stands may be considered the baseline data set. Often it is necessary to run the standard and non-standard scenarios (Section H) and review the results to determine if additional modifications need to be made to the data set before considering it the baseline. It is recommended that the baseline data set be saved once it has been established. The user is requested to enter up to three lines of comments describing the data set, and for the baseline, these comments should indicate that this data set is the baseline.

Often only the baseline data set need be stored. Any modifications made to the data set to test "What If" situations can simply be documented in the comments that are stored with the modeling results which were produced by using the modified data set to run the model. Storing the entire data set when only one small part of it was changed can be an unnecessary waste of disk space.

D. UNDO MODIFICATIONS TO DATA SET

This option is only offered after the data set has been modified.

It causes the reserved data set to be restored as the current data set. (The reserved data set is either Data Set 1 or the latest saved data set if one has been saved.) Note that any runs of the model which used the modified data set are stored along with the user's comments regarding the modifications made to the reserved data set, but unless the user has elected to save the modified data set itself, selecting to undo the modifications will cause the modified data set to be overwritten. SAFE requires the user to specifically choose to save a particular data set.

E. (FURTHER) MODIFY DATA SET

This option is only offered if the model has been run using the current data set.

The data set may be modified by changing any of the compartment, FRI, or barrier values, including openings. (The ship's geometry MAY NOT be changed at this point in the analysis without beginning a new analysis with an altered SHIP.DWG file. See Appendix N for a discussion of this process.)

The "(Further) Modify Data Set" menu is organized in a fashion similar to the original loading of the database with choices of modifying "Compartment Values", "Barrier Values" and "FRI Time Values". Modifications may be made to any or all three aspects of the database, and when the modifications are completed and the model is run, the Data Set number of the current data set is incremented and the modified data set becomes the new current data set.

In order that the user may exit SAFE and return to making modifications in another session, if modifications are made and the model is not run, the user will be asked upon re-entering SAFE if further modifications are to be made before running the model.

E.1. Compartment Values

Just as described in Section IV.C.4, the user may choose to modify compartment values either by assigning SAFE CUI defaults (see IV.C.4.1) OR by assigning/adjusting default values by CUI (see IV.C.4.2) OR by assigning/adjusting values by compartment (see IV.C.4.3).

Submenus identical to those offered when the compartment information was originally loaded are offered again for making modifications. Care should be taken when selecting either of the first two options since any individual compartment tailoring will be overwritten. However, it is possible to undo the modifications made after running the model on the modified data set.

E.2. Barrier Values

Modifying barrier values is subdivided into adding new barrier materials to database, making blanket changes to barrier materials or tailoring individual barrier values or openings assignments in AutoCAD as described in Section IV.C.5.3. Blanket and individual modifications may be made in any number and combination to barriers, then returning to the "Modify the Data Set" menu, but it logically makes sense to first make any desired blanket changes to a given barrier parameter then make individual exceptions to the blanket assignments if appropriate.

E.2.1. Review/Add Barrier Materials

This option allows the viewing/printing of the current barrier materials in the database as well as the addition of new ones. See Section IV.C.5.1.

E.2.2. Blanket Changes to Barriers

Blanket changes are group assignments to barrier values, similar to SAFE default values assigned by CUI, instead of each parameter being tailored individually. A typical blanket change could change all interior bulkheads with a barrier material ID of 'S2U' to 'S2I'. Blanket changes may be used to model "what if's" -- alternatives which may alter the fire safety of the vessel. The available blanket change options are:

- **Materials:** A barrier material currently assigned to bulkheads and overheads may be replaced with another. A database screen will display the types of barriers and their current barrier material IDs. If a new material ID is entered, all barriers of a given type assigned the current ID will be reassigned the new ID. Changes will be updated in the barrier blocks in SHIP.DWG the next time AutoCAD is entered.

- **Thermal Derating Factors**: The current thermal adjustment values for all barriers on the ship may be modified. A database screen listing all current values will appear. If a new value is entered, all barriers assigned the current value will be reassigned the new value. Changes will be updated in the barrier blocks in SHIP.DWG the next time AutoCAD is entered.

- **Durability Derating Factors**: The current durability adjustment values for all barriers on the ship may be modified. A database screen listing all current values will appear. If a new value is entered, all barriers assigned the current value will be reassigned the new value. Changes will be updated in the barrier blocks in SHIP.DWG the next time AutoCAD is entered.

- **View or Print Current Barrier Values Assigned**: This report lists all compartments and their associated barriers with barrier materials, derating factors, and openings to be reviewed to confirm that the desired changes have been made. Due the complexity of this report, it takes several minutes to prepare.

E.2.2. Individual Tailoring of Barriers/Openings in AutoCAD

Individual tailoring may also be used to model "what if's" -- changing the readiness condition of a watertight door, altering the derating factor for several barriers -- to see the effect on the ship's fire safety. This option works just as the original tailoring of barriers as described in Section IV.C.5.2. Selecting this option will take the user into AutoCAD where the values in the barrier blocks, including doors, may be re-tailored.

If any blanket changes were made to barriers before this option was selected, the barrier blocks will be updated automatically with the blanket changes before tailoring can begin.

When tailoring is done, it is necessary to create new extract reports by using the **EXTRACTS** command before **END**ing the drawing. These new extract files will be tested before AutoCAD is exited allowing any errors to be resolved in AutoCAD. When autoCAD is exited, the new files will be automatically loaded into the database.

IMPORTANT NOTE: Changes made in AutoCAD WILL NOT be registered in the database (and therefore will not be used by the model) unless the **EXTRACTS** command is run before

exiting SHIP.DWG. It is important that the values in SHIP.DWG reflect the contents of the database. Neglecting to create new extract files after tailoring will break the "link" between SHIP.DWG and the database.

E.3. FRI Time Values

Refer to Section IV.D. If any changes were made to compartment or barrier values which are used to calculate FRI times or post-FRI heat release rates, these values will automatically be recalculated. Then the same FRI Time menu presented in Section IV.D will reappear to allow the display of calculated FRI times and adjustments to the calculated FRI times if desired. If adjustments to FRI times were made prior to this data set modification, those adjustments are still in effect unless the user overwrites them. Remember to reconsider A & M values if FRI times were altered.

"Return to Previous Menu" will return the user to the "Modify Data Set" Menu and then to the "Run Probabilistic Model" Menu.

F. CHOOSE A PREVIOUS DATA SET

This option only appears if at least one data set has been saved.

At some point in the ship analysis, the user may wish to restore a previous data set for additional model runs or as a starting point for further modification. Choosing this option will display a list of the saved data sets, the date each set was stored, and comments supplied by the user when each set was stored. The current data set is NOT shown on the list. Only data sets which were specifically saved will be available.

Position the cursor at a data set and press **<F8>** to view the scenario used for each model run on that data set. Press **<esc>** to return to the data set list. Select the data set to become the current data set by entering **Y** in the column next to that data set, or press **<ctrl-c>** to exit the screen without selecting any previous data set. The selected data set, if there is one, will be re-loaded into the database and become the current data set.

If a previous data set is selected to be restored and the current data set has not been saved, the user will be prompted to save the current data set before restoring the previous one.

G. CLEAN UP LIST OF DATA SETS/MODEL RUNS

This option only appears if at least one data set has been saved.

After several data sets have been created and saved, it may be necessary to "clean house" by removing some unnecessary data sets to conserve disk space and simplify data set selection.

This option will display a screen listing the data sets which have associated model runs. If the data set was saved, the storage date is listed. The current data set is NOT listed and thus is not able to be deleted. Comments for a data set may be edited to reflect more accurately or completely the data set's contents. Modeling results may be deleted, as well as entire data sets if they were saved. When an entire data set is deleted, all model runs associated with it are also deleted. When model runs are deleted, the scenario options that were used to set up that run will no longer appear on the "Specify Scenario for Model Run" screen and the results of the model runs will no longer be available for viewing or printing.

G.1. To Delete a Data Set and All Associated Modeling Results:

From the data set selection screen, select the data set(s) to delete by entering **D** in the column next to the data set(s). Deleting a data set will delete the Set-# sub-directory and all model run results saved therein as well as the data set itself if it was saved. Press **<esc>** to delete the selected data sets, or **<ctrl-c>** to exit the screen without deleting any data sets. The "Run Probabilistic Model" menu will reappear.

G.2. To Delete Modeling Results Selectively:

Modeling results may be selectively deleted in two ways:

i. From the data set selection screen above, position the cursor at the appropriate data set and press **<F8>**. The window displaying the scenarios used for the model runs on that data set will appear. Results of a model run may be selected for deletion by entering a **D** in the "Delete Info?" column. Press **<esc>** to delete all selected model runs in that data set, or press **<ctrl-c>** to cancel the selections. The window will close, returning to the data set selection screen.

ii. From the "Examine Modeling Results" "Selected Model Runs" (Section B.2.) enter "D" next to any modeling results to be deleted.

H. SPECIFY SCENARIO FOR ANOTHER MODEL RUN

This option always appears on the "Run Probabilistic Model" menu.

When this option is selected, a screen to enter or update comments which pertain to the data set is first displayed. If the data set is potentially the ship's baseline, then the words "Preliminary baseline" may be enough. If this data set has been altered from the preliminary baseline, then a brief summary of the alterations would serve as comments to remind the user of the data set's contents. Press **<esc>** when comments are completed for the data set.

Then the scenario setup screen will appear and the desired scenarios for a "batch" of model runs may be specified. A new scenario may be specified ONLY by entering the desired options into a new, blank line in the list. For a ship's first model run, a new blank line automatically appears. For all subsequent scenarios, press **<F3>** to create a blank line, fill in the scenario, then <esc> to save it. Previous model runs on all data sets, identified by data set number and run number, are listed on the screen in the order they were run: with the most recent, first. These may not be altered. The arrow keys may be used to scroll through the list of previous model runs.

Select from the options described below to specify the scenario for the next model run on the current data set, then press **<esc>** to save the scenario and continue. To specify another model run in this "batch", type **Y** when prompted. The setup screen will reappear. Again, press **<F3>** to specify another scenario, fill in the options, and press **<esc>** to save them. When all desired scenarios for this "batch" are specified, press **<enter>** (instead of **Y**) at the prompt to begin the model runs.

NOTE: Before specifying any scenarios, read the remainder of this chapter, especially the final section (H.8), for guidance in setting up baseline scenarios.

H.1. Damage Control Readiness Condition

The first scenario option to be selected is: DC Readiness Condition: **X** or **Y**.

Ventilation and the status of doors and hatches (open/closed) are major factors in fire growth. The amount of ventilation is determined in part by the ship's damage control readiness condition, otherwise termed the material condition of readiness. Section 2.1.2 of the *Theoretical Basis* discusses the three material conditions of readiness, XRAY, YOKE, or ZEBRA. Before running the probabilistic model, the user may specify under which readiness condition the ship is operating:

> **X** - Xray (all X and NC doors and hatches are closed)
>
> or
>
> **Y** - Yoke (all X, Y, and NC doors and hatches are closed)

The model run will be performed after closing doors and hatches which would be closed under that condition.

Condition Zebra is set during the model run after a time (Tz) is reached. **Tz** is the sum of the time to fire detection (Td) plus the actual time to set condition Zebra (Ts):

$$\mathbf{Tz = Td + Ts}$$

Td is discussed further in the next section, "Ship Location". **Ts** is set based on the length of the ship and was determined on several ships of each of the following lengths:

ships < 180 feet:	Ts = 4 minutes
ships >= 180 feet and < 270 feet:	Ts = 5 minutes
ships >= 270 feet:	Ts = 6 minutes

Tz minutes after established burning in the room of origin is reached, condition Zebra is set, and the following three events occur:

i. All doors and hatches are closed except those designated 'O' (open) and those in compartments which have already reached full room involvement before Tz. Closing a barrier's doors or hatches significantly increases that barrier's ability to contain the fire.

ii. In compartments where doors and hatches are closed, the post-FRI heat release rate is reduced to its value as calculated under condition Zebra. SAFE calculates each compartment's heat release rate during the post-FRI period based on the compartment's ventilation. See Chapter 6.3.4.1 of the *Theoretical Basis* for the specific algorithm utilized. Thus there are potentially three rates of heat release in the post-FRI period for each compartment, one corresponding to each readiness condition (X,Y,Z).

iii. In compartments which have not reached full room involvement, FRI for compartments entered by thermal failure is adjusted to the FRI time during condition Zebra.

H.2. Ship Location

This scenario option allows the selection the of ship's location: **S**, at sea, or **P**, in port.

Higher manning levels on board when a ship is at sea imply that a fire on board is more likely to be detected at sea than in port. The values assigned for "% monitored at sea" and "% monitored in port" are utilized to determine **Td** (time to fire detection). For a ship location, Td will range from a low of 1 minute if the compartment is monitored over 75% of the time to a high of 16 minutes if the compartment is monitored less than 5% of the time.

H.3. Output Option

This scenario option allows selection of the type of output: **P**, **I**, **S**, **B**, or **R**.

The probabilistic model may present a variety of results. Although the **I** option (individual relative loss factors) has been the traditional favorite, the other options are helpful in providing more specific information. A scenario with the **R** option (critical run time) should be run on the

baseline data set before any other scenarios. See Sections B.2 and VI.G for the reports available from each output option. The following types of options may be requested:

P: Details of all **Paths** produced from one room of origin in a model run. When the output option P is selected for a scenario and the "Specify Scenario for Model Run" screen is exited, a screen will appear for selecting the room of origin from a listing of all compartments included in the analysis.

I: The relative loss factor of **Individual** compartments as targets for fires. Each compartment is used as a room of origin for a fire. Only those compartments which have a magnitude of acceptable loss (MAL) of 1-3 are used as targets, since a 4 rating indicates that burnout of the compartment is acceptable. The relative loss factor for an individual target is calculated by examining each fire path from each room of origin. If the target compartment is in the path and if its degree of fire involvement is greater than its MAL, then the value of 1 - cum L of the target at the time of its failure is multiplied by the room of origin's frequency of EB. The resulting value is added to a total for that target.

After all fire paths have been examined from fires in all rooms of origin, the resulting total (termed the relative frequency of loss given fire free state) is multiplied by the frequency of acceptable loss (FAL) to give a relative loss factor (RLF). If this factor is over 1.0, the fire objectives have not been met for this compartment. A value less than 1.0 indicates that the target compartment meets the fire objectives set for it. Chapters 4.4. and 6.6.3. of the *Theoretical Basis* further explain the comparison of performance with fire safety objectives.

S: The relative frequency of loss of **Sets** of compartments as targets for fire when a fire is started in each compartment. When the "Specify Scenario for Model Run" screen is exited and the output option S was selected for a scenario, a screen for selecting the compartments composing a target set will appear. As with the individual compartment option, eligible compartments include only compartments considered in the analysis with a MAL of 1-3. Compartments with a MAL of 4 are considered non-essential and may not be included in sets. When the first set has been composed, press **<esc>** to continue. A message will appear giving the option to create another set. Type **Y** to create another set or press **<enter>** to continue without creating another set. Up to ten sets of up to ten compartments each may be selected per scenario.

When the model is run, the user is asked to assign a FAL for each target set. This value functions for each set as the previously-assigned FAL does for each individual compartment. The value, in years, answers the question, "How frequently would it be acceptable to lose this set of compartments to fire?"

The relative frequency of loss for a target set is calculated just as for individual compartments, except that for a set to be declared lost, ALL of its members must have been declared lost in a fire from the same room of origin. After all fire paths have been examined in fires from all rooms of origin, the relative frequency of loss given fire free state is multiplied by the set's FAL to give a normalized loss factor. Again, if this factor is greater than 1.0, the fire objectives have not been met for this target set. A value less than 1.0 indicates that the target set meets the fire objectives set for it.

The user must determine which compartments logically belong in a target set. By considering a mission objective such as "maintaining the crew", the user identifies and selects the set of compartments which would be essential to meet that mission objective, i.e. the galley, dry provisions store, and reefer machinery room. All compartments in the set would have to be lost to fire to consider the set lost. Losing only the galley from the set would not be sufficient to cause a failure to meet that mission objective.

B: Probability of failure of room of origin **Barriers** in all compartments when each compartment is a room of origin. This option considers only fire protection in the room of origin and the strength of the room of origin's barriers as factors in fire spread. It provides a nice complement to the **I** option, enabling the rooms of origin which contribute most heavily to a target's loss to be more carefully examined.

R: Determination of critical **Run Time** based on option **I** above. The relative loss factors for all critical compartments are given at 10-minute intervals, from 20 to 60 minutes. The point in time beyond which there is a negligible increase in the relative loss factors for most compartments should be considered the critical run time for the ship and be used as the run time for subsequent modeling. If the relative loss factors appear to increase up to and including the 60 minute time, then the user may wish to use the **I** option with times greater than 60 minutes to see when relative loss factors "level off". It is not necessary to enter a model run time (H.5. below) when this output option is selected.

H.4. Fire Protection

This scenario option selects the level of fire protection.

Passive fire protection (I) is always in effect. By selecting various combinations of **A** and **M** levels, the user may see the contribution made by a ship's fixed extinguishing systems **(A)** and/or manual suppression **(M)**.

To simulate the following protection levels:

Passive fire protection only (I) - Enter "N" under both **A** and **M** on the screen to indicate only passive protection will be employed in the model run.

Passive and Fixed Systems (I and A) - Enter "Y" under **A** and enter the optional derating/enhancement factor for the **A** value (discussed below) if desired. During the "in port" condition, this option may give the most realistic look at "worst case" manual suppression when the ship is minimally manned.

Passive and Manual Suppression (I and M) - Enter "Y" under **M** and enter the optional derating/enhancement factor for the **M** value (discussed below) if desired.

Passive, Fixed Systems, and Manual Suppression (I, A, and M) - Enter "Y" under both **A** and **M**, and enter the optional derating/enhancement factors for the **A** and **M** values (discussed below) if desired.

DERATING/ENHANCEMENT FACTORS FOR A AND M:

A values may be derated or enhanced by up to 15%, **M** values by up to 30%. Enter a value between -15 (maximum derating) and +15 (maximum enhancement) for A values and -30 (maximum derating) and +30 (maximum enhancement) for M values under the **%** for each value. The default is zero. This factor allows improved or reduced overall active fire protection to be modeled for the current run without adjusting A and M values and creating a new data set.

H.5. Model Run Time (Duration of Fire)

This scenario option sets the total simulated fire time for the model run. It is NOT how long the computer will take to run the model. Enter a value between 2 and 120 minutes. If the fire time selected is less than the FRI time for a given room of origin, no fire paths will be created for that room of origin in that run of the probabilistic model. The simulated fire time actually produces a "snapshot" of the projected results at that time. By varying the time while keeping other variables constant, the results will show snapshots at various stages of fire growth. See output option **R** above to determine the critical run time for the ship.

H.6. Case

The next scenario option is: best/normal/worst case of barrier strength: **B**, **N**, or **W**.

Actually, these three cases are not well named, since in some instances, best case results may be worse than worst case results, with normal case results not necessarily falling between the two. With this in mind the three case options are best used to provide an envelope of results within which actual results for a given scenario may be assumed to lie.

> **B - Best Case:** The barrier fails allowing fire spread to the adjacent compartment when Dbar + Tbar > 0.9. The barrier is destroyed allowing heat to be dumped into the adjacent compartment when Dbar alone > 0.9.
>
> **N - Normal Case:** The barrier fails allowing fire spread when Dbar or Tbar > 0.0. The barrier is destroyed when Dbar = 1.0.
>
> **W - Worst Case:** The barrier fails allowing fire spread when Dbar + Tbar > 0.1. The barrier is destroyed when Dbar > 0.1.

H.7. FLLR

A Flammable Liquid Line Rupture (FLLR) is selected by entering **Y** and pressing **<enter>**. When the "Specify Scenario for Model Run" screen is exited and FLLR has been specified for a scenario, a screen will appear for selecting one engineering compartment in which a flammable liquid line rupture could occur (compartments where flammable liquid lines with fittings which could rupture causing the liquid to contact a surface hot enough to result in ignition.) SAFE assumes potential compartments to be a subset of compartments with CUI's of "EE", "EM", "QE", "QA". Listed with compartments having those CUI's is each compartment's assigned FRI time and I value when the compartment is the room of fire origin. Adjust either or both values to reflect a Flammable Liquid Line Rupture. Also enter an estimate of the ADDITIONAL gallons of flammable liquid that would be available to the fire after FRI is reached as a result of the flammable liquid line rupture. This value is converted to kBTU's and is added to the post-FRI fuel already available to the space, only for the one scenario and only when the compartment selected is the room of fire origin. In order to assign these values, the analyst must consider such things as the estimated rate of flow from the ruptured line, the type of flammable liquid involved, the estimated time to stopping the flow, etc. While this requires a great deal of engineering judgment by the analyst, it also allows much flexibility to model a specific scenario.

The resulting model run will utilize these newly-assigned values for FRI and I when the designated engineering compartment is the room of fire origin only. It will add the additional gallons of flammable liquid to the fuel already remaining in the compartment after FRI is reached. The values assigned will not replace the original values in the data set, but will be used just for the model runs where the FLLR option is selected.

H.8. Selecting Scenarios for a Baseline Analysis

As suggested in Chapter I, Section C.2.4, the user should run the probabilistic model on the baseline data set to acquire enough results to determine the ship's basic level of safety. This can be accomplished by first using the "R" (run time) output option (Section H.3) to determine the optimal run time for the subsequent 12 scenarios. Then set up the "I" (individual target) output option (Section H.3) using the optimal run time determined in the first model run (Section H.5) employing the worst case (Section H.6) and varying the damage control readiness condition (Section H.1), the ship's location (Section H.2), and fire protection levels (section H.4). Following is a summary of the initial scenario used to determine run time and of the subsequent twelve standard and non-standard scenarios:

	DC Cond.	Ship Loc.	Output Option	Fire Protection A	%	M	%	Run Time	Case	FLLR
TO DETERMINE OPTIMAL RUN TIME										
1.	X	P	R	Y	0	Y	0	0	W	N
STANDARD SCENARIOS (All fire protection in effect)										
2.	X	P	I	Y	0	Y	0	#*	W	N
3.	Y	P	I	Y	0	Y	0	#*	W	N
4.	Y	S	I	Y	0	Y	0	#*	W	N
NON-STANDARD SCENARIOS										
(Passive and automated fire protection only)										
5.	X	P	I	Y	0	N	0	#*	W	N
6.	Y	P	I	Y	0	N	0	#*	W	N
7.	Y	S	I	Y	0	N	0	#*	W	N
(Passive and manual fire protection only)										
8.	X	P	I	N	0	Y	0	#*	W	N
9.	Y	P	I	N	0	Y	0	#*	W	N
10.	Y	S	I	N	0	Y	0	#*	W	N
(Passive fire protection only)										
11.	X	P	I	N	0	N	0	#*	W	N
12.	Y	P	I	N	0	N	0	#*	W	N
13.	Y	S	I	N	0	N	0	#*	W	N

#* = critical run time determined after scenario 1.

For some ships where % monitored values are nearly identical for the "in port" and "at sea" condition, there may be no difference in results between the second and third scenarios of each set, in which case the YOKE/in port scenario may be ignored for this ship in future modeling. In other cases there may be either no XRAY or no YOKE rated accesses causing no difference in results between the first two scenarios. In that case the YOKE/at sea scenario may be ignored.

The standard procedure is to run the first scenarios to determine optimal run time, then set up and run the next 12 scenarios using that run time.

The data is then reviewed to determine which, if any, compartments require enhanced fire protection. A look at the detailed report which accompanies each standard and non-standard scenario run may be helpful in narrowing down the rooms of origin which are causing some target compartments to fail to meet fire safety objectives.

Alternatives to enhance protection may be simulated through modifications to the baseline data set (Section E). Scenarios 2, 3, and 4 at least should also be run on the modified data in order to compare results to the baseline results. The modified data set may be saved, becoming a new data set, or may continue to be modified and re-modeled.

CHAPTER V

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Chapter VI. VIEW/PRINT REPORTS AND FORMS

This option appears on the "SAFE Main Menu".

A. CHAPTER OVERVIEW

Throughout SAFE, reports and forms are offered for viewing and/or printing. This chapter describes nearly all reports and forms mentioned in the *SAFE User Manual.*

There are two categories of reports:

- **Database reports**, some of which are only available from the CURRENT data set. In order to generate database reports for a PREVIOUS data set, that data set must have been saved, and must be restored as described in Section V.B.2. Database reports are generally created for the baseline data set. Most database reports list the name of the ship being analyzed and the data set number in the upper right corner of the report. If, after a model run has been done and the data set may have been changed, the user is prompted as to whether or not it was modified, and, if so, 'mod' is printed after the data set number.
- **Modeling results**, which are not available until after a model has been run in Chapter V. Modeling reports list the name of the ship being analyzed and the set and run number, which consists of the data set number and the sequential model run number. Thus, "Model Run 2-12" indicates that this is model run 12 from data set 2.

In each of these categories there are two types of reports:

- **Text**, which are ASCII text files with a default page length of 65 lines. All of these may be viewed and/or printed.
  Viewing uses the DOS **MORE** command to display the report one screenful at a time. Press **<space>** to display the next screenful. To exit **MORE** without viewing all of a report, press **<ctrl-c>** and answer **N** to the prompt "Terminate Batch (y,n)".
  Printing sends the report to the system printer.
- **Graphic**, which are displayed as an AutoCAD drawing and can be printed or plotted or edited only from within AutoCAD. The display is most effective in color, but a black-and-white option is available. A format has been established for their display, but they may be edited using standard AutoCAD commands into whatever format is desired.

B. USER MANUAL APPENDICES

Many of the *SAFE User Manual* appendices were produced by database reports. Some of these reports merely list available types and will remain unchanged from ship to ship (Appendices B, C, and D). They may be printed if needed for inclusion in a fire safety analysis or to take on a ship visit. Other database reports, those which show SAFE default values in the appendices, will change as the database is loaded with the current ship data to replace the defaults (Appendices E and F). These may be printed throughout the process of loading and editing the database (Chapters IV, V) to show the current contents of the database. The available database appendices are described below.

B.1. Barrier Material Types

This report lists all of the barrier materials currently available in SAFE. Accompanying the ID and description of the material are the properties of the material which are utilized by SAFE to determine a barrier's effect on compartment's FRI time and fire spread to the adjacent compartment. These properties are described by the following parameters:

- Thickness (meters)
- Density (kg/m^3)
- Specific Heat (joules/kg)
- Thermal Conductivity (watts/m°K)
- Heat Release Rate (%) - used to determine how much heat is released into the adjoining compartment after a barrier is destroyed.
- Tbar x1, x2, x3 (kBTU/ft^2 of heat energy impact) - These three control points are used to determine the curve of a barrier's thermal performance where corresponding y axis values for y1, y2, and y3 of 0, 0.5, and 1 register the probability of barrier failure. See Chapter 6.3.4.2 of the *Theoretical Basis* for more information.
- Dbar x1, x2, x3 (kBTU's/ft^2 of heat energy impact) - These three control points are used to determine the curve of a barrier's durability performance where corresponding y axis values for y1, y2, and y3 of 0, 0.5, and 1 register the probability of barrier failure. See Chapter 6.3.4.2 of the *Theoretical Basis* for more information.

B.2. Opening Types

Door and hatch types available in SAFE are listed in this report and shown in Appendix B. The area and height used for each opening type is a best estimate of standard Coast Guard doors and hatches. Note that joiner doors and all of the watertight openings carry an additional designation as to their damage control readiness designation (NC, NO, O, X, Y, or Z). The readiness designation of an opening is the most critical component of the assignment of a type code.

B.3. Detection/Suppression System Types

All detection systems are automatic systems, while suppression systems may be further subdivided into fixed systems and manual fire fighting equipment. The current SAFE list is shown in Appendix C.

B.4. Fire Growth Models

Fire growth models are used to determine the pre-FRI growth rate (alpha) and the maximum allowable heat release rate (Qmax) for calculation of FRI time. The current SAFE list is shown in Appendix C of the *Theoretical Basis*.

B.5. CUI Default Values

Most of the fire parameters assigned by CUI have a normal minimum and maximum value (the "normal range") as well as a default value for each CUI. The user has the option of assigning a different default value to each of these parameters for each CUI or accepting SAFE's parameter defaults for each CUI (Section IV.C.4.2). This option allows printing of the SAFE normal range, default, and user-assigned value of each fire parameter (or group of compatible parameters) for each CUI. The reports are the same reports available in Section IV.C.4.2. After choosing option e. from the "User Manual Appendices" menu, the option is given to include all SAFE CUI's or just the CUI's appearing on the ship. Then a screen listing the fire parameters appears. Selecting one of the parameters will produce a report listing that parameter's normal range, SAFE default, and the user-assigned value for each CUI.

Appendix F shows a condensed version of the reports for all parameters listed, omitting the user-assigned value. If any of these reports are printed before Chapter IV is begun, the values given will be identical to Appendix F.

The parameters listed include:

- Cellulosic Fuel Load
- Plastics Fuel Load
- Total Gallons Fuel
- % Monitored at Sea
- % Monitored in Port
- Detection/Suppression Systems
- I: Room of Origin
- A: Room of Origin
- M: Room of Origin
- Vent Area and Height

C. DATA ENTRY WORKSHEETS AND FORMS

C.1. Ship Geometry Forms

This form is used for the optional preliminary ship visit. Its use is described in Section III.B and it may be printed at any time since it contains no ship-specific information. It consists of two parts:

- **Overall Ship's Geometry** - This form is used to record some general information about the ship, and a general sketch of each deck.
- **Compartment Geometry** - This form must be duplicated (on a copy machine) for each compartment on the ship and must be completed in sufficient detail to enable the ship's deck plans to be drawn in AutoCAD.

C.2. AutoCAD Drawing Worksheet

This form, printed in Section III.C.1, is used for keeping track of necessary information while creating the SHIP.DWG in Chapter III.

C.3. Ship Visit Form - Reference Data

This form, used for the ship visit described in Section IV.C.3., provides a quick reference to the SAFE codes representing barrier materials, opening types, fire growth models, and protection systems. These codes will be used to complete the ship, compartment, and barrier data forms described below.

C.4. Ship Visit Form - Ship Data

The information requested by this two-part form pertains to the ship's construction materials and general condition. The form is used during the recommended ship visit (Section IV.C.3). It may not be printed until Section IV.C.1 is completed or it will contain incomplete information. See Section IV.C.3 for more details.

C.5. Ship Visit Form - Compartment Data

These seven sets of forms, used for the recommended ship visit, are not available until Section IV.C.1 is completed. Compartments are ordered by CUI then fore/aft by layer. These forms are for recording of the data concerning each individual compartment. See Section IV.C.3, "Prepare for Ship Visit" for more details.

C.6. Ship Visit Form - Barrier Data Plots

AutoCAD will be automatically opened with S-layer #1 displayed. Each S-layer should be plotted in sufficient scale to allow recording of barrier material IDs, t and d adjustments, and doors and hatches on the appropriate barriers.

D. GENERAL SHIP INFORMATION

These reports provide information about the ship plans as recorded in the database, as well as information about the current status of the ship's geometry in the database.

D.1. Ship and Decks

For the ship, the report includes:

> overall barrier condition adjustment for Thermal and Durability,
>
> barrier material defaults for exterior hull and superstructure bulkheads and weather overheads, for interior bulkheads and weather overheads, and for watertight bulkheads.

For each deck, the report includes:

> The deck/layer number, the user-supplied deck name from SHIP.DWG, and the number of compartments in the database whose lowest level is on this deck.

D.2. Compartments by NAME

All compartments in the database are listed alphabetically by Name with Plan ID and CUI.

D.3. Compartments by PLAN ID

All compartments in the database are listed by Plan ID with CUI and Compartment Name.

D.4. Compartments by Compartment Use Indicator (CUI)

All compartments in the database are listed by CUI with Plan ID and Compartment Name.

D.5. Compartments by LAYER

All compartments in the database ordered by LAYER, fore to aft, are listed, with Deck Name, Plan ID, CUI, Compartment Name, Compartment Area and Compartment Height.

D.6. Compartments with Assigned Openings

The barriers in each compartment with openings currently assigned to them are listed. The opening type codes are the codes listed in Appendix B. The barriers are grouped by compartment, with the following information for each:

- The plan ID and name of the FROM: compartment.
- The plan ID and name of the TO: compartment (unless the barrier is a Weather Bulkhead or Weather Overhead).
- The type of opening in that barrier with the # of that type only if more than 1.
- The DC class of that opening.

E. USER ASSIGNMENTS BY COMPARTMENT

E.1. Fire Parameter Summaries

The reports available from this menu will group the fire parameter values assigned to each compartment into specialized reports. For all reports, CUI and its description are listed, then the compartments ordered by layer, fore to aft, with plan ID and name.

- Geometry - with compartment height and area
- Vents - with individual vents entered and total vents for compartment
- FSO's, Frequency of EB - with Magnitude and Frequency of Acceptable Loss
- Fire Detection - with number and type of Automatic Detection Systems,
  % Monitored and Est.Min. to Detection at Sea,in Port
- Fixed and Manual Suppression - with number and type of each system
- Probability of Flame Termination (I,A,M) - with values |EB, |TBAR, |DBAR
- Fuel Loads - with Cellulose(psf),Plastics(psf),Liquid Fuel(gals),
  Total Fuel(kBTUs/ft^2), Fire Growth Model, Stack Ht%, % Deck Occupied
- Fire Growth Models, Rates, and FRI Times - with Fire Growth Model, Alpha,
  Max.Q(kW), FRI(min) and Post-FRI Q(kW) for XRAY, YOKE, ZEBRA
- All of the above data for spreadsheet export to files in the directory '\safe*code*\ss.'

E.2. Barrier Values

The report available here is the same report available in Chapter IV with Assign & Tailor Barrier Values. It is a fairly slow report to run. It lists each compartment by plan ID and name and CUI with the plan IDs and names of its adjoining compartments, the area, material IDs, thermal and durability adjustment, and the doors/hatches for each barrier.

E.3. Detailed Report(s) by Compartment

SAFE offers a detailed report of the current data set values for every compartment and its associated barriers, ordered by deck/layer number and forward frame number. This shows the parameter values of the current data set used by the probabilistic model for each compartment and barrier, as well as assigned protection systems, although these are not considered directly by the model.

This report generates at least two pages for each compartment. Unlike all other reports, this one is sent directly to the printer with no option to view it first. Select whether to print detailed reports for all compartments or for selected compartments only. Footers with centered page numbering are available.

Information printed in the COMPARTMENT FIRE SAFETY SUMMARY includes:

- o A heading with Plan ID, Compartment Name, and CUI with CUI Description
- o GEOMETRY - Compartment Height (ft.), Total Vent Area (in.^{2}), Deck Area (ft.^{2}), Average Vent Height (in.)
- o FIRE SAFETY OBJECTIVES - Magnitude and Frequency of Acceptable Loss
- o FIRE DETECTION - % of Time Monitored at Sea and in Port
  Estimated Time to Detection at Sea and in Port (min.)
  AUTOMATIC DETECTION SYSTEMS: # and type
- o FIXED AND MANUAL SUPPRESSION
  FIXED SYSTEMS INSTALLED: # and type
  MANUAL EQUIPMENT AVAILABLE: # and type
- o PROBABILITY OF FLAME TERMINATION
  I, A, and M Values (%) and FRI|EB (min.) for Fire Causes:
  Originated in Compartment   Thermal Barrier Failure   Durability Barrier Failure
  Frequency of Established Burning (fires/compartment/year)
- o FUEL LOADS
  Cellulosics(psf), Plastics(psf), Total Liquid Fuel(gals)
  % Stack Height and % Deck Area Occupied by Fuel
- o FIRE GROWTH MODEL, RATES AND FRI TIMES
  Fire Growth Model and Description, Pre-FRI Fire Growth Rate, ALPHA (kW/sec.^{2})
  Maximum Heat Release Rate, MAXIMUM Q (kW)
  FRI Times|EB (min) and Post-FRI Heat Release Rates (kW) for XRAY, YOKE, ZEBRA

Information from the associated BARRIER FIRE SAFETY SUMMARY includes:

- Compartments Adjoining this Compartment: Names and Plan ID's
- Barrier Area (ft.^{2})
- Barrier Material ID's
- Barrier Tbar and Dbar Adjustment
- Numbers and types of Doors/Hatches with Readiness Condition

F. COMPARTMENT GRAPHICS

Several database parameters may be used to "color-code" the compartments of a ship. A black-and-white cross-hatching option is also available for compartment graphics. The available range colors/patterns are shown in Appendix M, Section A. General information for all graphic reports is discussed first, followed by specific information for each compartment graphic report.

GENERAL INFORMATION:

When any graphic report is chosen from this menu, a screen for grouping the compartments into ranges by their report values will appear. If the graphic report has been previously requested, the ranges used for the latest request appear as the default ranges. These defaults may, of course, be overwritten for this graphic report. Pressing **<F8>** will display the compartment plan ID's and their report values, with the most dangerous or least safe values first. A minimum of two ranges must be chosen, and as many as five may be chosen.

Once the desired ranges are set, press **<esc>** to save the ranges and continue. The file for the graphic report is then generated by the database. The drawing file used for all graphic reports, COLORS.DWG (see Appendix M) is automatically opened in AutoCAD, and the current report results are displayed. When the **COMMAND:** prompt appears, the report is complete and the user may edit the drawing by modifying text, moving text around, rearranging entities, etc., to achieve the desired effect. Printing or plotting a graphic report is done from within AutoCAD, using the **PRPLOT** or **PLOT** commands.

NOTE: Each time a graphic report is chosen from the menu, the same COLORS.DWG is used. The previous report results are **ERASEd** before the current results are displayed. If a drawing has been edited and the user wishes to save it, it must be saved from within AutoCAD to a file outside of the SAFE directory, preferably to a floppy disk, and given a name other than SHIP.DWG or COLORS.DWG. This may be done using AutoCAD's **SAVE** command or from the AutoCAD Main Menu, "6.File Utilities", before exiting AutoCAD.

When one of the compartment graphic reports is selected, the ranges setup screen lists the analyzed compartments by plan ID ordered by their report values as described above. Once the user chooses the range values, all compartments with values within the same range will be indicated by the same color (or hatch pattern) in COLORS.DWG.

Compartment graphics reports include:

- Frequency of Established Burning - The parameter used is the frequency of EB based on historical data which is assigned to each compartment by CUI. The larger frequencies of EB are considered most dangerous, so the values will be listed in decreasing order.

- Total Compartment Fuel Load - Total fuel load, in kBTU's, is used for this report. Total fuel is calculated based on the values assigned for cellulosic fuel, plastics, and gallons of flammable liquids. Since the largest values are the most dangerous, the values are listed in decreasing order.

- Fuel Load Density - Fuel load density, in kBTU's/ft.^{2}, is used for this report. It is calculated based on the values assigned for cellulosic fuel, plastics, and gallons of flammable liquids. Since the largest values are the most dangerous, the values are listed in decreasing order.

- Probability of Fire Self-Termination (I) - Each compartment's I value given as room of origin is used for creating this report. The smallest I values, reflecting the lowest probability that a fire in the compartment would self-extinguish, are the least safe values, so the values will be listed in increasing order.

- Automatic Detection Priority - An Automatic Detection Priority is assigned to each compartment based on a fire detection value calculated as:

  Frequency of EB * max{% UNmonitored at sea, % UNmonitored in port} * FAL/MAL

  The compartments with the highest priority, i.e. priority 1, would be of greatest concern. The values will be in increasing order.

G. MODELING RESULTS

This section displays the same menu and reports available in Chapter V "Run Probabilistic Model" "Examine Modeling Results".

G.1. Index of ALL Model Runs

This report lists each Data Set with its comments and whether or not the set was stored. Under each Data Set are listed the model runs and their options as set up for the run.

G.2. Selected Model Runs

When this option is selected, the user will first select the model run results to view, then the type of results to view. A screen appears with all model runs listed in the order they were run, the most recent first. Enter a **P** next to the run results to be examined, and/or **D** next to the model run results to be deleted. Press **<esc>** to continue or **<ctrl-c>** to cancel out of the screen.

The runs marked for deletion, if any, will be deleted, then the Reports Available menu below for the first run to be examined will appear. When results of the first run selected have been reviewed, the process will repeat for the next run selected. When all selected runs have been reviewed, the "Modeling Results" menu will reappear.

Reports Available for Set-# Run-#

This menu will appear for each of the model runs selected.
Depending on the output option of the run, there may be up to three choices available:

Summary Level Report
Detail Level Report
Graphic Report

For the two text reports, Summary and Detail, the view/print menu will appear. Graphic reports will be handled as described in Section F. For certain output options, only one type of report (usually Summary Level) is available, and only the view/print menu will appear.

In addition, but not on the Reports Menu, SAFE provides a file listing Individual targets and their RLF in a format that may be imported into an electronic spreadsheet. See Section V.B.2.

G.2.1. Summary Level Report

All of the output options listed in Section V.C.3 (Path, Individual Target, Target Set, Barrier, and Run Time) offer a summary level report. This type of report offers an overview of the model run results. More detailed information for all output options, except Barrier, can be obtained after reviewing the summary level report by selecting the detail level report described below. A description of the summary level report for each output option follows:

G.2.1.1. Path Option

The paths resulting from one run of the model are listed with the following information:

- Plan ID of each compartment in the path separated by a "/"
- Path's Cum L - the probability that the fire will terminate in the final compartment in the path at the time the run ends. See the *Theoretical Basis*, Chapter 6.3.5. for a discussion of Cum L and the L curve.

G.2.1.2. Barrier Option

Each compartment being analyzed is used as a room of fire origin for a model run. The report lists each room of origin ordered by layer, fore to aft. The barriers surrounding each room of origin are listed following the room of origin ordered by the probability of loss given EB in the adjacent room at the time of the barrier's failure. The following information about the room of origin and each of its barriers is provided:

- Room of Origin's Plan ID
- FRI time (minutes) - Room of Origin's FRI time for the selected condition of readiness (Xray or Yoke).
- Room of Origin's Probability of Loss given EB
- Relative Frequency of Loss of the Room of Origin given Fire Free State x 1000 which is computed as (the Probability of Loss given EB) x (the Frequency of EB of the Room of Origin) x 1000.
- Adjacent Compartment's Plan ID
- Time (in minutes) that the barrier fails from the start of the model run
- Probability of Loss given EB of the adjacent compartment
- Relative Frequency of Loss of the adjacent compartment given Fire Free State x 1000
- Whether the barrier had an open access or was a zero-strength barrier

G.2.1.3. Individual Target Option

Each compartment being analyzed is used as a room of fire origin for a model run. Only compartments being analyzed with a MAL of 1-3 are considered as possible targets for fire. Each target compartment with an RLF greater than 0.0000 is listed and ordered by its RLF.

The following information is provided:

- Magnitude of Acceptable Loss (MAL) - The assigned rating for the magnitude of fire loss that would be considered acceptable for this compartment.
- Frequency of Acceptable Loss (FAL) - The assigned number of years between loss of this compartment which would be acceptable.
- Relative Frequency of Loss | Fire Free State - The probability of "losing" a target compartment is determined by summing the probabilities of losing the compartment over all fire paths from every possible room of origin. A compartment is considered lost when the criteria specified as acceptable in its assigned MAL is exceeded. This probability of loss is multiplied by the frequency of established burning in each room of origin to determine the frequency of loss given fire free state.
- Relative Loss Factor - The relative frequency of loss is multiplied by the FAL to determine the relative loss factor. Factors with a value greater than 1.0 fail to achieve the stated objectives.

G.2.1.4. Target Set Option

Each compartment being analyzed is used as a room of fire origin for a model run. Each user-defined set of compartments is considered as a possible target for fire. This report lists each compartment set ordered by its relative loss factor. The following information is provided:

- Frequency of Acceptable Loss (FAL) - The assigned number of years between loss of this set of compartments which would be acceptable.
- Relative Frequency of Loss | Fire Free State - The probability of "losing" a target set is determined just as for individual compartments, except that for a set to be declared lost, all of its members must have been declared lost in a given model run.
- Relative Loss Factor - The relative frequency of loss is multiplied by FAL to determine the relative loss factor for the target set. Factors with a value greater than 1.0 fail to achieve the stated objectives.

G.2.1.5. Run Time Option

This report lists the relative loss factors for each compartment at 10 minute intervals, from 20 to 60 minutes. In most compartments, the relative loss factors will rise sharply until a critical time is reached when the values for most compartments begin to level off. This critical time is usually the most desirable run time to use for a ship analysis. If a leveling off does not occur by 60 minutes, then 60 minutes is the recommended critical run time.

G.2.2. Detail Level Report

All output options, except Barrier, offer a detail level report. In general, the detail level report should be obtained if the summary level report results indicate a need to examine the model run results in further detail. This detailed report may be **quite lengthy** depending on the number of fire paths formed by running the model. An alternative to printing the entire report would be to view the path of concern on the screen and use the keyboard's "Print Screen" key to send desired portions of the screen display to the printer.

G.2.2.1. Path Option

Each path listed in the summary path report is dissected into detailed information about each compartment and barrier in the path.

Listed for each compartment in the path are the following:

- Plan ID
- Cum L - the probability at the end of the model run that the fire will be terminated in this or any other previous compartment in a path.
- Ign Mode - the means by which this compartment reach EB, either "orig" (room of origin), "therm" (ignited by thermal barrier failure from an adjacent compartment), or "dur" (ignited by durability barrier failure from an adjacent compartment).
- EB Time - the time it took this compartment to reach EB in this model run.
- Compt Fuel (kBTU/ft.^{2}) - the fuel remaining in the room after running the model for the specified time.
- Therm IAM (%) - the probability that a fire is terminated in the room set by a thermal failure due to the combination of the I, A, and M curves for that room. If the room is a room of origin, the Therm IAM value is not applicable.
- Dur IAM (%) - the probability that a fire is terminated in the room set by a durability failure due to the combination of the I, A, and M curves for that room. If the room is a room of origin, the Dur IAM value is not applicable.
- FRI Time (mins.) - the time needed for this compartment to reach FRI in this model run.
- CBO - the minute of the model run when compartment burnout occurred, if it occurred.

For each barrier in the path, the report lists:

- HEI (kBTU/ft.^{2}) - the Heat Energy Impact (HEI) that was attacking this barrier at the time it was destroyed or at the close of the model run, whichever came first.
- Tbar (%) - the probability that this barrier underwent a thermal failure at the close of this model run.
- Dbar (%) - the probability that this barrier underwent a durability failure at the close of this model run.
- IBV (%) - the probability that this barrier will not fail in this model run, (Intermediate Barrier Value).
- Time Destroyed - the minute of the model run when the barrier's Dbar value is greater than 0.9 in a best case model run or > 0.1 in a worst case model run.
- Failure Type - describes how the barrier failed; either thermally ("therm") or through a durability failure ("dur"). A barrier is considered to have failed in a best-case model run if **Dbar + Tbar > 0.9**, and in a worst-case model run if **Dbar + Tbar > 0.1**. The barrier is assigned a thermal failure if **Tbar > Dbar**, and a durability failure if **Dbar >= Tbar.** Note that a barrier has a Tbar and Dbar value for each side, and if either side exceeds the failure criteria, the barrier is considered to have failed. Also note that a barrier's failure is not the same as a barrier being destroyed. When a barrier has failed, EB is started in the next compartment. When a barrier is destroyed, it is no longer attacked when running the model.

G.2.2.2. Barrier Option

Unlike other detail level reports, this report is merely a reordering of the barrier option's summary level report. Each compartment being analyzed is used as a room of fire origin for a model run. The report lists all room of origin barriers ordered by the probability of loss given EB in the adjacent room at the time of the barrier's failure.

The following information about the barriers is provided:

- Room of Origin's Plan ID
- FRI time (minutes) - The FRI time for this room of origin for the selected condition of readiness (Xray or Yoke).
- Room of Origin's Probability of Loss given EB
- Adjacent compartment's Plan ID
- Time (in minutes) that the Barrier fails from the start of the model run
- Probability of Loss given EB of the adjacent compartment
- Whether the barrier had an open access or was a zero-strength barrier

G.2.2.3. Individual Target Option

For each target compartment which is lost in a run of the model from any room of origin, a listing of all paths which involved that compartment is provided with the following information about each path:

- 1-Target Cum L | FFS - Calculated by:

  (1 - Cum L) * Freq EB

  where "Cum L" is the probability of success in limiting the fire in this target compartment, "1 - Cum L" then becomes the probability of failure in limiting the fire in this compartment, and "Freq EB" is the room of origin's frequency of EB. This value is referred to as the probability of losing this target compartment in this fire path. Note that by adding all of these values for each path in which this target was involved, one arrives at the "Relative Frequency of Loss | FFS" from the summary target report.
- Target EB (mins.) - The time in a model run when this target compartment reached EB.
- Path - The plan ID's of the compartments in the path, always ending with the target compartment. The path may have gone beyond the target compartment, but the path is only listed to the target compartment.

G.2.2.4. Target Set Option

For each target set which is lost in a model run from any room of origin, a listing of all paths which involved that set is provided grouped by the compartments in the set. The same information provided for the detailed report of individual targets is provided for target sets.

G.2.3. Graphic Report

Only the Individual Target output option offers a graphic report, described below. It is created, set up, and displayed just as the database graphics reports described in Section F. The largest relative loss factors are the most dangerous, so the values are listed in decreasing order.

G.2.3.1. Individual Target Option

The relative loss factors calculated for each compartment during a model run are used for this report. The larger factors are considered most dangerous and are listed first on the ranges setup screen, with the values listed in decreasing order. It is recommended that all relative loss factors greater than one be grouped as the first range in order to display them as compartments which failed to meet objectives.

Chapter VII. ARCHIVE SHIP / CLEAN UP SAFE

This option appears on the "SAFE Main Menu".

A. CHAPTER OVERVIEW

This chapter describes how to remove the current ship data set and all of its data files from the database. The ship may be archived, which will save all data files for later use, or deleted, which will not save any of the data. The SAFE program files will not be removed, only files related to the ship currently being analyzed.

The options on this menu may be done at any point during the entry or analysis of a ship. When a ship is archived or deleted, SAFE is ready to begin again with another ship as discussed in Chapter II.

Restoring an archived ship for further analysis is handled from the initial menu ("Select Ship to Analyze") and is discussed in Section II.D., "Restore/Analyze Archived Ship".

To remove the entire SAFE program itself from the hard disk, it is necessary to delete all files and remove all sub-directories from the \SAFE directory. Any special system-specific SAFE setup files (AUTOEXEC.BAT, CONFIG.SYS, etc.) that may have been created in Section I.D may also be deleted, although it is recommended to save these to a floppy if SAFE is to be re-installed. Once removed, SAFE may be reinstalled at any time from the original installation disks following the procedure in Chapter I.

B. ARCHIVE SHIP/CLEAN UP SAFE

This option appears on the Main Menu.

When this option is selected, if the probabilistic model has been run and the dataset has been modified without being saved, the user will be given a choice to UNDO the changes; otherwise, the following three options appear:

B.1. Clean Up List of Data Sets

This option allows the deletion of unwanted data sets and/or saved modeling results. This option may be used at any time once Chapter V is begun. It is recommended to use this option before archiving a ship to prevent storing unwanted data sets. It is not necessary to clean up the list if the ship is to be deleted.

Once selected, this option will display a list of the stored data sets, the date each set was stored, and comments supplied by the user when each set was stored. The comments stored for a data set may be edited from this screen.

TO DELETE SAVED MODELING RESULTS:

Position the cursor at the desired data set and press **<F8>** to view the scenario used for each model run of that data set. Any model run results that were saved (Section D.2) may be deleted from this subscreen by entering a **Y** in the "Delete Info" column. Press **<esc>** to delete all selected model run results or press **<ctrl-c>** cancel the selections. The data set list will reappear.

TO DELETE A DATA SET:

Select the data set(s) to delete by entering **Y** in the column next to the data set(s). Deleting a data set will also delete all saved model run results associated with it. Press **<esc>** to delete the selected data sets, or **<ctrl-c>** to exit the screen without deleting any data sets.

When all desired data sets and/or modeling results have been deleted, the ship is ready to archive.

B.2. Archive Current Ship Data

Archiving a ship consists of unloading the current data set from the database and saving all input and output files associated with that ship. Once restored (Section II.D.), analysis of an archived ship can continue from the point it was when archived. This may be necessary if another ship is to be analyzed before the current ship is completed.

To begin:

Select "Archive Current Ship Data" from the menu. When the option to continue is chosen, a message appears giving the name of the directory where the ship files will be stored. This is a sub-directory named \SAFE*code*\FINAL, where *code* is the SHIP CODE (Section V.B).

Directories containing any other data sets created for this ship (SET-#) during modeling (Chapter V) are also under this *code* directory and will also be saved. The current data set at the time of archiving will be the current data set upon restoring the ship.

Once the archive is complete, the "Select Ship to Analyze" menu appears and SAFE is ready to begin analysis of another ship.

If disk space is at a premium, it is possible to backup all files and sub-directories under the *code* directory then delete them from the hard disk, as long as the directory structure is maintained on the backup. Use of the DOS **XCOPY** command with the /S switch is recommended for this purpose. These files and sub-directories must be returned to their original places under the *code* directory before the ship may be restored for further analysis.

B.3. Delete Current Ship Data Without Saving

Deleting a ship without saving will remove the ship completely from SAFE by deleting the current data set from the database completely and deleting all other files associated with the ship. This includes all AutoCAD files in the \SAFE\IO directory, all files under the *code* directory created during modeling, and the reference to the ship in the SAFE database. Once a ship is removed by this option, there is no way to restore the ship in SAFE. This method may be desired if a ship analysis has been completed and there is no longer any need for the ship data in SAFE.

To begin:

Choose "Delete Current Ship..." from the menu. When the option to continue is selected, a message will appear stating that the information for the current ship is being deleted.

When the procedure is complete, the "Select Ship to Analyze" menu will reappear and SAFE is ready to begin analysis of another ship.

APPENDIX A

SAFE PROVIDED BARRIER MATERIALS
(Metric Units)

ID	Descripton	Structural or Non	Thickness m	Density kg/m^3	Spec Ht J/kg.C°	Therm.Cond W/m.C°	Ht Rel %	Tbar X-1 (kW/m^2)	Tbar X-2 (kW/m^2)	Tbar X-3 (kW/m^2)	Dbar X-1 (kW/m^2)	Dbar X-2 (kW/m^2)	Dbar X-3 (kW/m^2)
000	Zero-strength (includes screening and grating)	N	0.000	0	0	9999.00	100	0	0	0	0	0	0
A2I	1/4" Aluminum with thermal insulation	S	0.050	2600	200	5.00	5	568	1136	1893	568	1136	1893
A2U	1/4" Aluminum	S	0.006	2657	963	126.34	15	0	379	757	757	1136	1893
C5U	5/8" Celotex (overhead: below crawl space layer)	N	0.016	24	700	0.04	25	189	568	757	189	568	757
F2U	1/4" Fiberglass Toilet/Shower Enclosure	N	0.006	1380	960	0.15	35	379	946	1325	4732	6624	7571
NPI	Nomex honeycomb core - plastic laminate & insulation	N	0.051	50	1210	0.04	30	379	1514	1893	1703	3407	4164
NPU	Nomex honeycomb core - plastic laminate facing	N	0.017	48	1210	0.07	30	379	1136	2650	568	2271	3785
NSU	Nomex honeycomb core - stainless steel facing	N	0.017	50	1210	0.08	25	1514	3785	5678	10410	15142	19873
P7P	7/8" Plywood - plastic laminate facing, both sides	N	0.022	540	1215	0.12	15	1136	2271	3975	1893	3785	5110
S2I	1/4" Steel with thermal insulation	S	0.051	7800	100	1.00	5	946	2839	3407	14195	18927	22712
S2U	1/4" Steel	S	0.006	7840	500	45.30	5	189	757	1893	11356	15142	18927
S3I	3/8" Steel with thermal insulation	S	0.051	7800	100	1.00	5	1136	3407	3785	15142	20820	24605
S3U	3/8" Steel	S	0.010	7840	500	45.30	5	189	757	1893	12303	16088	19873
S4I	1/2" Steel with thermal insulation	S	0.051	7800	100	1.00	5	1136	3407	3785	15142	20820	24605
S4U	1/2" Steel	S	0.013	7840	500	45.30	5	379	946	2271	13249	17034	20820
S5U	5/8" Steel	S	0.016	7840	500	45.30	5	379	946	2271	14195	17981	21766

APPENDIX A

SAFE PROVIDED BARRIER MATERIALS

(English Units)

ID	Descripton	Structural or Non	Thickness inches	Density lb/ft^3	Spec Ht BTU/lb.F°	Therm.Cond BTU/min.ft.F°	Ht Rel %	Tbar X-1	Tbar X-2	Tbar X-3	Dbar X-1	Dbar X-2	Dbar X-3
								$kBTU/min.ft^2$			$kBTU/min.ft^2$		
000	Zero-strength (includes screening and grating)	N	0.000	0	0.000	96.29	100	0	0	0	0	0	0
A2I	1/4" Aluminum with thermal insulation	S	2.000	162	0.048	0.05	5	3	6	10	3	6	10
A2U	1/4" Aluminum	S	0.250	166	0.230	1.22	15	0	2	4	4	6	10
C5U	5/8" Celotex (overhead: below crawl space layer)	N	0.625	1	0.167	0.00	25	1	3	4	1	3	4
F2U	1/4" Fiberglass Toilet/Shower Enclosure	N	0.250	86	0.229	0.00	35	2	5	7	25	35	40
NPI	Nomex honeycomb core - plastic laminate & insulation	N	2.000	3	0.289	0.00	30	2	8	10	9	18	22
NPU	Nomex honeycomb core - plastic laminate facing	N	0.625	3	0.289	0.00	30	2	6	14	3	12	20
NSU	Nomex honeycomb core - stainless steel facing	N	0.625	3	0.289	0.00	25	8	20	30	55	80	105
P7P	7/8" Plywood - plastic laminate facing, both sides	N	0.875	34	0.290	0.00	15	6	12	21	10	20	27
S2I	1/4" Steel with thermal insulation	S	2.000	487	0.024	0.01	5	5	15	18	75	100	120
S2U	1/4" Steel	S	0.250	490	0.119	0.44	5	1	4	10	60	80	100
S3I	3/8" Steel with thermal insulation	S	2.000	487	0.024	0.01	5	6	18	20	80	110	130
S3U	3/8" Steel	S	0.375	490	0.119	0.44	5	1	4	10	65	85	105
S4I	1/2" Steel with thermal insulation	S	2.000	487	0.024	0.01	5	6	18	20	80	110	130
S4U	1/2" Steel	S	0.500	490	0.119	0.44	5	2	5	12	70	90	110
S5U	5/8" Steel	S	0.625	490	0.119	0.44	5	2	5	12	75	95	115

APPENDIX B

OPENING TYPES

Type	Construction	DC Readiness Rating	Area (sq.ft.)	Height (in.)
HATCHES:				
HS	Small watertight hatch or scuttle	X,Y,Z	4.50	NA
HL	Large watertight hatch	X,Y,Z	10.30	NA
HO	Hatch or Ladder opening	O	12.00	NA
DOORS:				
DWT	Watertight Door or Window	X,Y,Z	12.00	66
DO	Door Opening	O	16.25	78
DJ	Joiner Door or Window	NC,NO	16.25	78

DC Conditions of Readiness

Condition	Access Rating Status: Open	Access Rating Status: Closed
XRAY	Y, Z, NO, O	X, NC
YOKE	Z, NO, O	X, Y, NC
ZEBRA	O	X, Y, Z, NC, NO

APPENDIX C

DETECTION/SUPPRESSION SYSTEMS

AUTOMATIC DETECTION SYSTEMS:

FLM	Flame
SMO	Smoke
TMP	Temperature

SUPPRESSION SYSTEMS:

		Fire Class Effectiveness
FIXED FIRE PROTECTION SYSTEMS		
A3F	AFFF Sprinkler	AB-
APC	Aqueous Potassium Carbonate	-B-
CO2	CO_2 total flooding	-BC
HAL	Halon 1301 total flooding	-BC
W	Water sprinkler	AB-
MANUAL FIRE FIGHTING EQUIPMENT:		
Portable Extinguishers		
CO2	CO_2	-BC
HAL	Halon 1211	-BC
MAP	Mono-Ammonium Phosphate	ABC
PKP	PKP	-BC
SB	Sodium Bicarbonate	-BC
Hose Reels		
A3F	AFFF	AB-
C02	CO_2	-BC
PKP	PKP	-BC
Fire Main Stations		
A3F	AFFF/Seawater	AB-
SW	Seawater Only	AB-

APPENDIX D

FIRE GROWTH MODELS

Model #	Description	Typical CUI's
1	Stacked Wood Pallets	AA,AG,AS,QL
2	Storage of stacked paper/lignocellulosics	AA,AG,AS,K
3	Storage of stacked plastics in cartons	AA,AG,AS,K
4	Stacked mail bags, 5' high	AA,AG,AS
5	Storage of unstacked cellulosics and plastics	AA,AG,AS,K
6	Paper-filled polyethylene letter trays	C,QA,QE,QO,QS,QW
7	Polyethylene wire insulation; polysynthetics	C,EE,QA,QO,QS,QW
8	Office spaces	C,QA,QE,QO,QS,QW
9	Lounge spaces	LL,LM,QO
10	Berthing areas	L1,L2,L5
11	Hanging polyurethanes	AG,AS,L1,L2,L5,QL
12	Hanging cellulosics	AG,AS,L1,L2,L5,QL
13	Greasy, sooty spaces	EM,QA,QE,QF,QG,TH,TU
14	Stairways	LP
15	Passageways	LP
16	Very low density storage	AR-S,LP-W,QF,TH,TU,V

APPENDIX E

SAFE CUI INPUT DATA - NORMAL RANGES AND DEFAULT VALUES**

CUI	Description	TOTAL VENT AREA (sq.in.) Normal Min	Max	Def.	AVE. VENT HEIGHT (in.) Normal Min	Max	Def.	MONITORED AT SEA (%) Normal Min	Max	Def.	MONITORED IN PORT (%) Normal Min	Max	Def.
AA	Cargo Hold	10	200	50	50	150	75	5	95	10	5	100	10
AG	Gear Locker	0	500	250	0	100	20	0	95	0	0	95	0
AR	Refrigerated Storage	0	0	0	0	0	0	5	20	5	0	15	0
AS	Storeroom	0	500	100	0	150	25	5	95	10	5	95	10
C	Ship Control/Communications	0	1500	250	0	100	20	5	95	95	5	95	25
EE	Main Propulsion - Electrical	100	1500	1000	10	200	30	25	95	95	20	95	95
EM	Main Propulsion - Mechanical	100	1500	1000	10	200	30	25	95	95	20	95	95
F*	Fuel, Lube, or Dirty Oil Tanks												
J*	JP-5 Fuel Tanks												
K	Hazardous Material Storage	0	350	0	50	100	100	0	95	95	0	95	95
L1	Senior Officer's Cabin	0	1500	350	0	50	10	50	95	95	50	95	95
L2	Officer/CPO Quarters	0	1500	350	0	50	20	50	95	95	25	95	95
L5	Crews Berthing	0	1000	400	0	50	10	50	95	95	25	95	95
LL	Wardroom/Mess/Lounge Areas	100	1500	500	5	100	20	50	95	95	50	95	95
LM	Medical/Dental Spaces	0	400	150	0	10	5	25	95	95	5	95	95
LP	Passageway/Staircase/Vestibule	0	3500	200	0	150	10	0	95	20	0	95	15
LW	Sanitary Spaces	25	600	200	0	100	10	0	95	20	0	95	15
M*	Explosives												
QA	Aux Machinery Spaces	0	1000	150	0	200	50	0	95	10	0	95	10
QE	Emergency Aux Generator Spaces	50	250	150	10	150	50	0	95	95	0	95	95
QF	Fan Room	0	3000	2000	0	75	50	0	95	0	0	95	0
QG	Galley/Pantry/Scullery	0	750	250	0	100	20	50	95	95	25	95	95
QH*	Helicopter Hangar												
QL	Laundry	0	600	300	0	75	20	25	95	95	20	95	95
QO	Office Spaces	0	400	150	0	10	5	25	95	95	5	95	95
QS	Shops	50	350	250	50	125	75	0	95	95	0	95	95
QW	Wet and Dry Labs	50	350	250	50	125	75	0	95	95	0	95	95
TH	Trunks/Hoists/Dumbwaiters	5	50	10	1	10	1	5	25	15	0	20	10
TU	Stacks/Engine Uptakes	0	1500	1000	0	75	25	0	95	0	0	95	0
V	Voids/Cofferdams	0	25	0	0	50	0	0	0	0	0	0	0
W	Water Tank (empty)	0	0	0	0	0	0	0	0	0	0	0	0

* Not considered in analysis

** Developed from input data used in fire safety analysis of nine small Coast Guard cutters

APPENDIX E (continued)**

CUI	Description	CELLULOSIC FUEL (psf) Normal Min	Max	Def.	PLASTICS FUEL (psf) Normal Min	Max	Def.	LIQUID FUEL (gallons) Normal Min	Max	Def.	ROOM OF ORIGIN (%) I Normal Min	Max	Def.	A Normal Min	Max	Def.	M Normal Min	Max	Def.
AA	Cargo Hold	1.00	5.00	3.50	0.20	4.00	1.50	0	15	0	5	70	66	0	0	0	5	50	25
AG	Gear Locker	0.00	65.00	20.00	0.00	30.00	6.00	0	0	0	0	95	27	0	0	0	5	95	25
AR	Refrigerated Storage	0.00	2.50	0.50	0.00	2.50	0.50	0	10	0	0	75	70	0	0	0	0	50	34
AS	Storeroom	1.00	50.00	10.00	0.50	20.00	1.50	0	50	1	10	95	39	0	0	0	0	75	20
C	Ship Control/Communications	0.50	12.00	4.00	0.10	4.00	1.00	0	0	0	10	75	39	0	0	0	10	50	20
EE	Main Propulsion - Electrical	0.20	2.50	0.50	0.00	2.00	1.00	0	10	0	10	50	43	0	95	61	5	40	10
EM	Main Propulsion - Mechanical	0.20	2.50	0.70	0.20	1.75	0.50	0	75	25	10	50	43	0	95	49	5	40	10
F*	Fuel, Lube, or Dirty Oil Tanks																		
J*	JP-5 Fuel Tanks																		
K	Hazardous Material Storage	0.20	15.00	0.50	0.00	0.50	0.20	0	50	35	10	25	16	25	95	75	5	25	11
L1	Senior Officer's Cabin	2.00	8.00	5.00	0.00	2.00	1.20	0	0	0	10	60	49	0	0	0	10	50	23
L2	Officer/CPO Quarters	3.00	12.00	6.50	0.00	4.00	1.40	0	0	0	10	70	49	0	0	0	10	50	23
L5	Crews Berthing	4.00	20.00	8.00	0.00	6.00	1.60	0	0	0	20	70	42	0	0	0	5	40	26
LL	Wardroom/Mess/Lounge Areas	1.00	6.00	3.00	0.20	4.00	1.00	0	0	0	15	90	39	0	0	0	5	60	35
LM	Medical/Dental Spaces	2.00	20.00	12.50	0.50	5.00	3.50	0	5	3	5	50	46	0	0	0	15	60	20
LP	Passageway/Staircase/Vestibule	0.00	4.00	3.00	0.00	3.00	0.75	0	0	0	50	95	78	0	0	0	40	95	48
LW	Sanitary Spaces	0.00	4.00	2.30	0.00	2.00	0.40	0	0	0	60	95	79	0	0	0	20	95	30
M*	Explosives																		
QA	Aux Machinery Spaces	0.00	9.00	2.00	0.00	7.00	1.60	0	35	5	30	95	50	0	45	0	5	95	9
QE	Emergency Aux Generator Spaces	0.50	5.00	1.00	0.20	2.00	1.50	0	25	15	40	75	43	25	95	67	5	50	10
QF	Fan Room	0.00	0.50	0.20	0.00	0.30	0.20	0	0	0	50	95	73	0	0	0	10	30	29
QG	Galley/Pantry/Scullery	0.50	5.00	2.00	0.10	5.00	0.80	0	10	1	15	90	73	0	0	0	10	50	23
QH*	Helicopter Hangar																		
QL	Laundry	2.00	12.00	4.00	0.50	5.00	2.00	0	0	0	20	60	21	0	0	0	15	45	23
QO	Office Spaces	2.00	25.00	7.50	0.50	5.00	2.00	0	0	0	15	75	32	0	0	0	15	50	20
QS	Shops	0.20	1.00	0.40	0.20	1.00	0.30	0	0	0	20	45	43	0	0	0	10	30	23
QW	Wet & Dry Labs	0.20	1.00	0.40	0.20	1.00	0.30	0	0	0	20	45	43	0	0	0	10	30	25
TH	Trunks/Hoists/Dumbwaiters	0.50	1.50	1.00	0.10	1.00	0.50	0	0	0	60	99	96	0	0	0	10	50	34
TU	Stacks/Engine Uptakes	0.10	5.00	2.00	0.00	1.50	0.90	0	0	0	10	35	32	0	0	0	3	35	6
V	Voids/Cofferdams	0.00	2.00	0.10	0.00	2.00	0.10	0	0	0	90	99	99	0	0	0	90	95	95
W	Water Tank (must assume empty)	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	95	100	100	0	0	0	95	95	95

* Not considered in analysis

** Developed from input data used in fire safety analysis of nine small Coast Guard cutters except for I, A, and M default values which were calculated (see attached sheets).

APPENDIX F

SAFE CUI INPUT DATA DEFAULT VALUES

CUI	Use Description	Ventilation Factors: Vent Area (sq.in.)	Vent Ht. (in.)	% Monitored: Sea	Port	Automatic Detection	Fuel Load: Cell (psf)	Plas (psf)	Liquid (gals)	I	A	M	Frequency of EB** (fires/cpt.year)	FSO's***: MAL Rating	FAL (years)
										EB (%)					
AA	Cargo Hold	50	75	10	10		3.50	1.50	0	66	0	25	0.0001	3	13
AG	Gear Locker	250	20	0	0		20.00	6.00	0	27	0	25	0.0010	4	8
AR	Refrigerated Storage	0	0	5	0		0.50	0.50	0	70	0	34	0.0009	2	22
AS	Storeroom	100	25	10	10		10.00	1.50	1	39	0	20	0.0009	4	8
C	Ship Control/Communications	250	20	95	25		4.00	1.00	0	39	0	20	0.0012	2	25
EE	Main Propulsion - Electrical	1000	30	95	95	2 TMP	0.50	1.00	0	43	61	10	0.0031	2	25
EM	Main Propulsion - Mechanical	1000	30	95	95	2 TMP	0.70	0.50	25	43	49	10	0.0272	2	25
F*	Fuel, Lube, or Dirty Oil Tanks														
J*	JP-5 Fuel Tanks														
K	Hazardous Material Storage	0	100	95	95	1 TMP	0.50	0.20	35	16	75	11	0.0013	1	30
L1	Senior Officer's Cabin	350	10	95	95	1 SMO	5.00	1.20	0	49	0	23	0.0008	3	11
L2	Officer/CPO Quarters	350	20	95	95	1 SMO	6.50	1.40	0	49	0	23	0.0008	3	11
L5	Crews Berthing	400	10	95	95	2 SMO	8.00	1.60	0	42	0	26	0.0008	3	11
LL	Wardroom/Mess/Lounge Areas	500	20	95	95	1 TMP	3.00	1.00	0	39	0	35	0.0008	2	21
LM	Medical/Dental Spaces	150	5	95	95		12.50	3.50	3	46	0	20	0.0001	3	14
LP	Passageway/Staircase/Vestibule	200	10	20	15		3.00	0.75	0	78	0	48	0.0001	3	14
LW	Sanitary Spaces	200	10	20	15		2.30	0.40	0	79	0	30	0.0002	3	11
M*	Explosives Storage														
QA	Aux Machinery Spaces	150	50	10	10		2.00	1.60	5	50	0	10	0.0029	2	24
QE	Emergency Aux Generator Rooms	150	50	95	95		1.00	1.50	15	43	67	10	0.0204	2	23
QF	Fan Room	2000	50	0	0		0.20	0.20	0	73	0	29	0.0004	3	18
QG	Galley/Pantry/Scullery	250	20	95	95	1 SMO	2.00	0.80	1	73	0	35	0.0026	2	22
QH*	Helicopter Hangar														
QL	Laundry	300	20	95	95	1 SMO	4.00	2.00	0	21	0	23	0.0031	3	10
QO	Office Spaces	150	5	95	95		7.50	2.00	0	32	0	20	0.0004	3	15
QS	Shops	250	75	95	95		0.40	0.30	0	43	0	23	0.0018	3	12
QW	Wet & Dry Labs	250	75	95	95		0.40	0.30	0	43	0	25	0.0018	3	12
TH	Trunks/Hoists/Dumbwaiters	10	1	15	10		1.00	0.50	0	96	0	34	0.0001	3	10
TU	Stacks/Engine Uptakes	1000	25	0	0		2.00	0.90	0	32	0	6	0.0013	3	16
V	Voids/Cofferdams	0	0	0	0		0.10	0.10	0	99	0	95	0.0001	4	8
W	Water Tank (must assume empty)	0	0	0	0		0.00	0.00	0	100	0	95	0.0004	4	8

* Not considered in analysis

** Frequency of EB obtained from US Navy and US Coast Guard data compiled between 1975 and 1991.

*** FSO's determined in accordance with procedures outlined in Appendix J.

APPENDIX G

SAFE CUI INPUT DATA DEFAULT FORMULAS

Calculating I, A, and M Values for Adjacent Compartments

I = I|EB (I Value as Room of Origin)

A = A|EB (A Value as Room of Origin)

M = M|EB (M Value as Room of Origin)

Note: Calculated values less than 0 are assigned 0, greater than 100 are assigned 100.

CUI	Use Description	Entered by TBAR failure I¦TBAR	A¦TBAR	M¦TBAR	Entered by DBAR failure I¦DBAR	A¦DBAR	M¦DBAR
AA	Cargo Hold	Ix1.25	A	Mx1.8	Ix0.75	Ax0.5	Mx0.75
AG	Gear Locker	Ix1.25	A	Mx1.2	Ix0.6	Ax0.5	Mx0.6
AR	Refrigerated Storage	Ix1.2	A	Mx1.2	Ix0.8	Ax0.5	Mx0.8
AS	Storeroom	Ix1.1	A	Mx2	Ix0.6	Ax0.5	M
C	Ship Control Area	Ix1.1	A	Mx1.1	Ix0.6	Ax0.5	Mx0.6
EE	Main Propulsion - Electrical	Ix1.1	A	Mx1.25	Ix0.6	Ax0.5	Mx0.6
EM	Main Propulsion - Mechanical	Ix1.1	A	Mx1.25	Ix0.6	Ax0.5	Mx0.6
F*	Fuel, Lube, or Dirty Oil Tanks						
J*	JP-5 Fuel Tanks						
K	Hazardous Material Storage	I	A	M	Ix0.5	Ax0.5	Mx0.5
L1	Commanding Officer's Cabin	Ix1.2	A	Mx1.3	Ix0.5	Ax0.5	Mx0.6
L2	Officer/CPO Quarters	Ix1.1	A	Mx1.6	Ix0.6	Ax0.5	Mx0.7
L5	Crews Berthing	I	A	Mx2	Ix0.6	Ax0.5	Mx0.9
LL	Wardroom/Mess/Lounge Areas	Ix1.1	A	Mx1.25	Ix0.6	Ax0.5	Mx0.6
LM	Medical/Dental Spaces	Ix1.1	A	Mx1.25	Ix0.6	Ax0.5	Mx0.6
LP	Passageway/Staircase/Vestibule	I	A	Mx1.1	Ix0.9	Ax0.5	Mx0.9
LW	Sanitary Spaces	I	A	Mx1.1	Ix0.8	Ax0.5	Mx0.9
Mx	Explosives Storage						
QA	Aux Machinery Spaces	I	A	Mx1.1	Ix0.7	Ax0.5	Mx0.75
QE	Emergency Aux Generator Spaces	I	A	Mx1.1	Ix0.6	Ax0.5	Mx0.75
QF	Fan Room	Ix0.8	A	Mx2.5	Ix0.6	Ax0.5	Mx0.75
QG	Galley/Pantry/Scullery	I	A	Mx1.4	Ix0.6	Ax0.5	Mx0.8
QH*	Helicopter Hangar						
QL	Laundry	Ix1.25	A	Mx1.5	Ix0.75	Ax0.5	Mx0.6
QO	Office Spaces	Ix1.2	A	Mx1.25	Ix0.6	Ax0.5	Mx0.6
QS	Shops	Ix1.1	A	Mx1.2	Ix0.6	Ax0.5	Mx0.6
QW	Wet & Dry Labs	Ix1.1	A	Mx1.2	Ix0.6	Ax0.5	Mx0.6
TH	Trunks/Hoists/Dumbwaiters	Ix1.1	A	Mx1.2	Ix0.6	Ax0.5	Mx0.6
TU	Stacks/Engine Uptakes	Ix1.1	A	Mx1.3	Ix0.6	Ax0.5	Mx0.6
V	Voids/Cofferdams	I	A	M	I	Ax0.5	M
W	Water Tank (must assume empty)	I	A	M	I	Ax0.5	M

* Not considered in analysis

APPENDIX H

SAMPLE COMPARTMENTS FOR EACH COMPARTMENT USE INDICATOR (CUI)

CUI	GENERAL DESCRIPTION	COMPARTMENTS
AA	Cargo Hold	Cargo Hold Science Storage
AG	Gear Locker	Cleaning Gear Locker Arctic Gear Locker Athletic Gear Locker Sea Bag Locker Stack Chair Locker Life Jacket Locker Boat Gear Locker Bosn's Locker
AR	Refrigerated Storage	Reefer Space Frozen Storeroom Thaw Room Chill Room Ready Issue Reefer
AS	Storeroom (all spaces labeled "Storeroom", "Stowage", or "Issue Room" except those covered under CUI's AA, AG, AR, K, and M)	Ship's Store Storeroom Service Baggage Electronic Storeroom Dry Provision Stores Soda Storage Engineer's Storeroom Science Storeroom Medical Stores Electrical Storeroom Hawser Storeroom Baggage Room Scientist Baggage Room

(AS continued next page)

CUI	GENERAL DESCRIPTION	COMPARTMENTS
AS	Storeroom (continued)	Aft/Forward Repair
		Provision Issue/Handling
		Stores Handling Room
		Tool Issue Room
		Landing Force Equipment
		Shipping and Receiving
C	Ship Control/Communications	Pilot House (Bridge)
		Engineering Control
		Control Booth
		Forward Repair
		Aft Repair
		Science/Winch Control
		Helicopter Landing Control
		Generator Control Room
		Missile Safety Station
		Combat Information Center
		Radar Room
		Electronic Countermeasures
		Electronic Warfare Room
		Sonar Room
		Launcher Control Room
		Monitoring Area
		Ham Shack
		Weapons Local Control Room
		Communications Center
		Radio Room
		IC/Gyro Room
EE	Main Propulsion Spaces-Electrical	Motor Room
		Motor-Generator Room
		Generator Room

APPENDIX H

CUI	GENERAL DESCRIPTION	COMPARTMENTS
EM	Main Propulsion Spaces-Mechanical	Engine Room Boiler Room Gas Turbine Room Bow Thruster Machinery Rm Fidley
F	Fuel Oil, Lube Oil Tanks	Fuel Oil Tank Clean Lube Oil Tank Dirty Lube Oil Tank Hydraulic Oil Tank
J	JP-5 Fuel Tanks	JP-5 Storage Tanks JP-5 Service Tanks
K	Hazardous Material Storage	Paint Locker Paint Mix & Issue Room Flammable Liquid Hazardous Materials
L1	Senior Officer Stateroom	1-Person Stateroom C.O.'s Cabin Chief Scientist Qtrs Senior Scientist Qtrs Visitor's Stateroom
L2	Officer/CPO Quarters	2-Person Stateroom Officers Stateroom CPO Quarters
L5	Crews Berthing	>= 3-Person Berthing First Class Quarters Seamans Berthing Petty Officers Berthing

APPENDIX H

CUI	GENERAL DESCRIPTION	COMPARTMENTS
LL	Wardroom/Mess/Lounge Areas	Wardroom
		CPO Mess
		Crews Mess
		Crews Lounge
		Recreation Deck
		Crews Study/Library
		CO's Lounge
		Ship Store
		Soda Fountain
		CCTV Studio
		Scientist Library
		Conference Room
		Weight Room/Gym
		Hobby Shop
LM	Medical/Dental Spaces	Sick Bay
		Battle Dressing Station
		Pharmacy
		Recompression Area
LP	Passageway/Staircase/Vestibule	Passageway
		Access Space
		Staircase
		Vestibule
		Ladder Compartment
LW	Sanitary Spaces	Washroom
		Water Closet
		Shower Space
		Crews Head
		Watchstander's Head
		Officers Head
		Fresh Water Decontamination

APPENDIX H

CUI	GENERAL DESCRIPTION	COMPARTMENTS
M	Explosives Storage	Magazine
		Fuse Storage
		Small Arms Magazine
		Powder Room
		Handling Room
		Torpedo Storage Room
		Ready Service Locker
		Projectile Magazine
		Armory
		Missile Comp Hoist Trunk
		Handling/Ready Service Room
QA	Aux Machinery Spaces	Battery Storage Room
		Ship's Service Generator
		Switchboard Room
		Converter Room
		Load Center
		Power Supply Room
		Radar Equipment Room
		Sonar Equipment Room
		Director Equipment Room
		Electronic Warfare Room
		Electronic Equipment Room
		Computer Room
		Data Processing Center
		Air Navigation Equipment Rm
		Weapon System Equipment Rm
		Electronic Equipment Rm
		Xmfr Rect Helo
		Aux Machinery Space
		Lazarette
		After Steering
		Reefer Machinery
(QA continued next page)		Anchor Windlass Machy

CUI	GENERAL DESCRIPTION	COMPARTMENTS
QA	Aux Machinery Spaces (continued)	Firefighting Equip Rm
		Winch Room
		Pump Room
		Electrical Equipment Rm
		Air Conditioning Machy
		Steering Gear Room
		Hydraulic Pump Room
		Hoist Equipment Room
		Bow Boom Instrument Rm
		Refrigeration Machinery
		Cooling Equipment Rm
		Machinery Hoist Rm
		Classified Waste Disposal Rm
		Compressor Room
		Eductor Room
		Helicoptor Service Reel Rm
		Helicopter Traversing Winch Rm
		Sewage Plant
		Shaft Alley
		Trash Compactor Rm
		Garbage Disposal Rm
		Windlass Room
		Waste Heat Boiler Room
		Elevator Machinery Room
		Fidley
QE	Emergency Aux Generator Spaces	Emergency Generator
		Emergency/Harbor Generator
QF	Fan Room	Fan Room

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CUI	GENERAL DESCRIPTION	COMPARTMENTS
QG	Galley/Pantry/Scullery	Galley
		Pantry
		Scullery
		Incinerator Room
		Utensil Wash Area
QH	Helicopter Hangar	Balloon Shelter
		Helo Hangar
QL	Laundry	Ships Laundry
		Self Service Laundry
QO	Office Spaces	Ships Office
		Supply Office
		Barber Shop
		QM Shelter
		Scientist Comm Center
		Helo Equip Room
		Commissary Office
		Aviation Office
		Administration Room
		Repair Parts Record Center
		Unit Commander Briefing
		Career Counselor Rm
		Security Station
		Registered Publication Rm
		CO/Flag Officer Cabin
		Damage Control Central
		Mail Room
		Log Office
		Ships Store
		Ships Office
		Library
		XO/EO/1st LT Office
		Chartroom

APPENDIX H

CUI	GENERAL DESCRIPTION	COMPARTMENTS
QS	Shops	Electronic Shop
		Electrician's shop
		Machine Shop
		Oceano Lab
		DC Shop
		Maintenance Room
		Instrument Room
QW	Wet and Dry Labs	Wet Lab
		Dry Lab
		Photo Lab
		Electronics Lab
		Computer/Nav Lab
		Meteorology Lab
		X-Ray Darkroom
		Gravimeter Room
TH	Trunks/Hoists/Dumbwaiters	Access Trunk
		Escape Trunk
		Vertical Conveyor Trunk
		Sonar Trunk
		Elevator
		Elevator Trunk
		Machinery Hoist
		Kingpost Trunk
		Dumbwaiter
		Dumbwaiter Trunk
		Intake Room
		Intake Trunk
		Ventilation/Intake Plenum
		Filter Room
		Vent Trunk

APPENDIX H

CUI	DESCRIPTION	COMPARTMENTS
TU	Stacks/Engine Uptakes	Stack Space Engine Uptakes Fidley
V	Voids/Cofferdams	Voids Cofferdams
W	Water/Peak/Ballast Tanks (Must assume empty in simulation)	Potable Water Tanks Peak Tanks Gray Water Tank Sewage Tank Roll Stabilization Tank Ballast Tank Bilge Tank

APPENDIX I

PLAN ID CONVENTIONS

Plan ID's are assigned to a ship's compartments to provide unique identifiers describing the location and general use of the compartment, using a standard convention for most military vessels. A compartment plan ID of **04-126-0-Q** reflects the following:

04 - the deck level number where this compartment's DECK is located. If a compartment extends through more than one level, the plan ID is assigned according to the lowest level of the compartment (the location of its deck). The main deck is given a 1 deck level number. Decks above it start with 01 and continue 02, 03, etc. Decks below it are numbered 2, 3, etc. downward. Note that the deck level number does not correspond to the deck/layer numbers used in SAFE. The functions of these two numbers are completely different.

126 - the forward frame number. Walking from the bow of the ship, this is the frame number of the bulkhead from this compartment reached first. If the compartment's forward bulkhead falls between forward frame numbers, the frame number WITHIN the compartment is used. If the frame is forward of frame 0, a letter is used.

* **0** - the compartment's port/starboard indicator. This describes the order of compartments sharing the same forward frame number from the centerline out, odd numbers indicating starboard and even numbers indicating port, viewed while facing forward from the stern of the ship. Looking at the plan view plots, if the bow of the ship points to the right, the odd numbers will be "below" the centerline and the even numbers "above". As the port-starboard indicator increases, its position away from the centerline increases. A "0" means that the room straddles the centerline of the ship. A "1" would indicate that the compartment is the first compartment at that forward frame number on the starboard side of (below) the centerline. A "2" would denote the first compartment at that forward frame number on the port side of (above) the centerline.

Q - the general use indicator. This describes the compartment's use. From [3], standard use indicators are as follows:

APPENDIX I

A: Storage areas such as issue rooms, refrigerated stores, and storerooms (closets).

AA: Cargo-carrying storage such as cargo holds or refrigerated cargo compartments.

C: Ship and fire control operating areas normally manned, such as Combat Information Center (CIC), Communications Office, Electronic Operating Areas, Pilothouse, IC Rooms, and Plotting Rooms.

E: Machinery areas which are normally manned, such as Auxiliary Machinery Rooms, Evaporator Rooms, Main Machinery Areas, Pump Rooms, Refrigerating Machinery Rooms, Emergency Generator Rooms, Steering Gear Rooms.

F: Fuel oil, Diesel oil fuel, and lubricating oil tanks.

G: Gasoline tanks.

GG: Cargo gasoline tanks.

J: JP-5 tanks.

K: Stowage of chemicals and semi-safe and dangerous materials except oil and gasoline tanks.

L: Living quarters, medical and dental areas, stairways (ladders), and passageways.

M: Ammunition (stowages and handling).

Q: Areas not otherwise covered such as engineering, electrical, and electronic areas not normally manned, galley, laundry, offices, pantries, shops, wiring trunks.

T: Vertical access trunks.

V: Void compartments such as cofferdam compartments, ballast wing tanks.

W: Compartments storing water, including bilge, sump, and peak tanks.

* SAFE uses an exception to the port/starboard convention for compartments added to SHIP.DWG for modeling purposes only. If the addition of these compartments causes a duplicate plan ID to exist, add a letter to the port-starboard indicator. Examples of these compartments are passageways broken into parts by zero-strength barriers or ladders which are modeled as compartments (See Section III.D.2).

For example, if a compartment's plan ID was 01-85-3-L and the compartment was broken into three parts, they would become 01-85-3A-L, 01-85-3B-L, and 01-85-3C-L. They all keep the basic plan ID of the original compartment. If the new sections of the original compartment do not all share the original forward frame number, their new plan ID's should still reflect the forward frame number of the original compartment. The extra letter in the port/starboard position field designates the compartment was added for modeling purposes. Because these extra compartments' plan ID's bear such a close resemblance to each other, it is easy to determine what the original compartment was before it was subdivided.

If a completely new compartment such as a ladder compartment is added, INCLUDE the additional letter in the port/starboard indicator of the new plan ID to signify that the compartment was added for modeling purposes.

APPENDIX J

SETTING FIRE SAFETY OBJECTIVES FOR FLAME MOVEMENT

It is necessary to establish Fire Safety Objectives (FSO's) for each compartment on a cutter that will be analyzed by SAFE. The two components of FSO's are the Magnitude of Acceptable Loss (MAL) and the Frequency of Acceptable Loss (FAL).

A. MAL

The MAL is a rating assigned to each compartment assessing the magnitude of the fire loss which is acceptable. This rating may range from established burning (EB) not being acceptable (1) to complete burnout of the compartment being acceptable (4):

Rating	Loss Level
1	EB is not acceptable
2	EB is acceptable but full room involvement (FRI) is not
3	FRI is acceptable but Compartment Burnout (CBO) is not
4	CBO is acceptable

A compartment's MAL is assigned a rating of 1-4 depending on its essentiality to the ship's missions, life safety considerations, and potential cost of property damage. For the Flame Movement Module of the SFSEM (which this version of SAFE implements), the ship's primary mission may be more heavily weighted than other considerations. If primary mission alone were considered, compartments whose total loss (CBO) would not significantly affect the ship's mission would be assigned a rating of 4. For example, most sanitary spaces, gear lockers, passageways, voids, water tanks, ladders, and certain storerooms, if totally lost, would not prevent the ship from performing its mission. Note that a compartment may contain a sizable fuel load and contribute materially to the spread of a fire, but if its loss would not affect the ship's mission, it would receive a rating of 4. At the other extreme are flammable materials storage lockers, paint lockers, and other compartments containing flammable materials which could contribute materially to the spread of a fire and result in mission loss if they even reach EB. These spaces would be assigned a rating of 1.

The balance of the compartments would be assigned a rating of 2 or 3. In general, if the compartment contains equipment vital to the ship's primary mission, and if its loss would likely result in the ship aborting its patrol and returning to homeport for repairs, it would be assigned a 2. On the other hand, if the compartment's loss would degrade, but not prevent, the ship's ability to perform its primary mission, it would receive a 3 rating. Examples of compartments typically rated 2 are the Engine Room, Bridge, and Galley. Berthing Areas, Ship's Offices and Labs/Workshops would typically be assigned a 3 rating.

While primary mission may be the dominant concern of the SFSEM's Flame Movement Module, other considerations should not be ignored. Using engineering judgment similar to that discussed for assigning MAL's for primary mission, MAL's should also be assigned for secondary mission, life safety and property protection. SAFE's developers have formulated an equation, printed below, for combining MAL's for all four considerations to arrive at one composite MAL which SAFE requires. The weighting factors that were assigned to each consideration may be adjusted by the SAFE user to be more consistent with the FSO's of the ship being analyzed.

$$MAL = (0.1 \times LS) + (0.3 \times PP) + (0.4 \times PM) + (0.2 \times SM)$$

where

LS = MAL for Life Safety | *PP = MAL for Property Protection*
PM = MAL for Primary Missions | *SM = MAL for Secondary Missions*

NOTE: This equation will yield a "real" number; only the integer value is used for the MAL rating. The "real" number is used in the calculation for FAL as described in the next section. The relatively low weighting factor (0.1) assigned to Life Safety (LS) is considered appropriate because, unless a person is imtimately involved with the start of a fire, they are not generally harmed by the "flame." As the current version of SAFE only considers flame movement, this weighting factor seems appropriate.

B. FAL

The FAL defines how frequently the loss sustained in a compartment can be tolerated. Its value may range from 1 loss per year to 1 loss per 30 years. SAFE developers consider a compartment's FAL to be loosely coupled to its MAL. For example a compartment rated 1 would be allowed to be lost much less frequently than a compartment rated 4. While both values may be assigned using engineering judgment, SAFE developers have developed a correlation between MAL and FAL that is described by the following equation:

$$FAL = 32.25 - (1.766 \times MAL) - (0.214 \times MAL^2) - (0.222 \times MAL^3)$$

The SAFE user may elect to use other considerations and weighting factors to assign the MAL or use alternative reasoning to assign the FAL, thereby establishing Fire Safety Objectives in a different manner from that described above. Because of this possibility, the calculation of MAL and FAL as described in the equations above are not implemented in SAFE Version 2.2. If the user wishes to utilize these equations, they may easily be entered into an electronic spreadsheet and used to calculate MAL and FAL.

APPENDIX K

CLASSIFYING LADDERS

In SAFE, ladders are modeled as a combination of hatches and compartments. To create accurate connectivity between compartments, each ladder must be examined and assigned a classification based on the way each end of the ladder is (or is not) enclosed.

Refer to the five Types (I-V) below and classify each ladder on the ship. Following the instructions for each class, record the classifications on the plan view plots (Section III.D.1.1).

In Section III.E, ladders to be modeled as compartments (Type III, IV, or V below) are drawn as separate compartment polylines in SHIP.DWG and these new compartments are given their own Plan ID's, compartment names (Ladder), and CUI's (LP). Refer to the note at the end of Appendix G for guidance in assigning the Plan ID. Remember to include the number of ladder compartments on each deck to the deck compartment totals on the worksheet, part 4.

The classifications and methods for representing each ladder in SHIP.DWG are as follows:

I. The ladder is completely open or is enclosed only by handrails with no bulkheads around either end. It connects two compartments on the same s-layer which surround a stepped deck or two areas within one compartment. Examples: Figure K-1(a): a small ladder connecting two compartments on the same deck or Figure K-1(b): a ladder in a multi-deck engine room connecting the catwalks to the deck.

   This ladder type is ignored. Do not assign a Plan ID and do not include in SHIP.DWG.

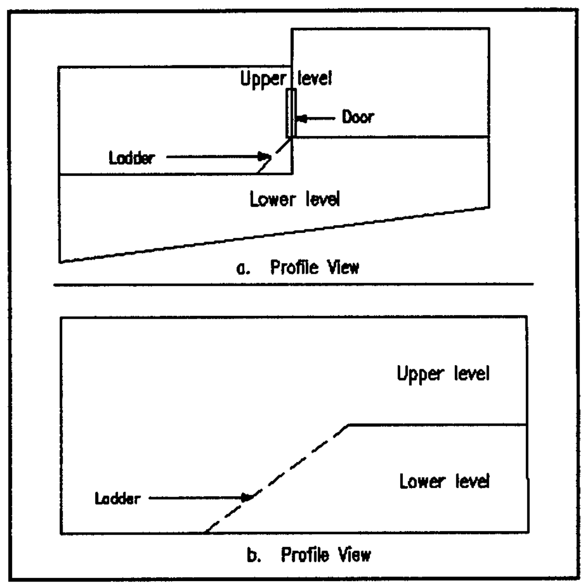

Figure K-1 Class I Ladders

II. Two cases:

a. The ladder is open, enclosed only by handrails, and joins two compartments on adjacent decks through an opening in the overhead connecting the two compartments. Example: Figure K-2a.
This type is modeled as a ladder hatch. Do not assign a Plan ID. Insert a **HATCH** block in the overhead on the "o-layer" of the lower level.

b. The ladder is open and connects two compartments on adjacent decks through an opening in a bulkhead created by a stepped deck. Example: Figure K-2b.
This type is modeled as either a door or an open doorway. Do not assign a Plan ID. Insert a **DOOR** block on the bulkhead.

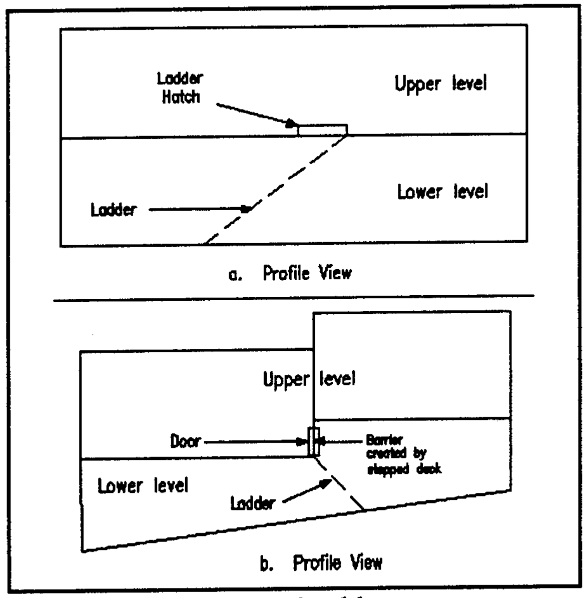

Figure K-2 Class II Ladders

III. The ladder joins two compartments on adjacent decks, but is surrounded by only handrails or nothing at all on one deck (the OPEN end) and enclosed by bulkheads on the other deck (the CLOSED end).

The CLOSED end may have an open doorway or a door and will be considered a compartment and assigned a name, Plan ID, and CUI. It should be drawn in SHIP.DWG as a polyline on the appropriate s-layer.
Insert a **DOOR** block at the appropriate end of the polyline representing the closed end to indicate the access. This **DOOR** block is required even for an open doorway.
The OPEN end is connected to the closed end by a hatch, and does not get a plan ID. Insert a **HATCH** block on the lower deck's "o-layer".
Examples: Figure K-3(a) or (b), depending on which end of the ladder is closed.

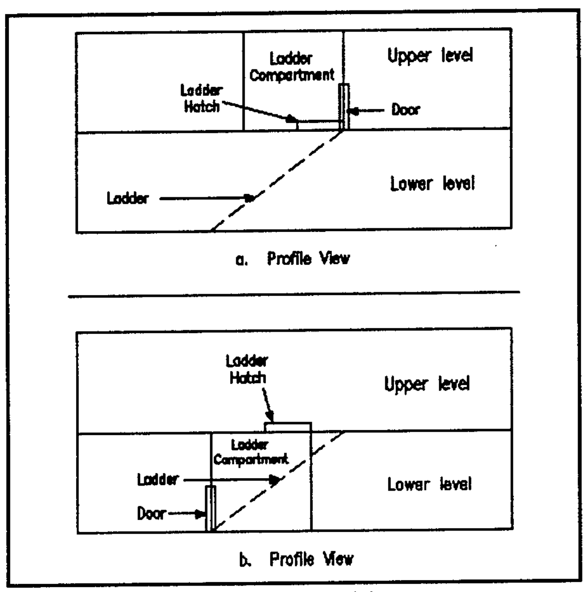

Figure K-3 Class III Ladders

IV. The ladder joins two compartments, but is enclosed by bulkheads on both decks. Each end may have an open doorway or a door. The ladder is considered as one compartment spanning two decks, but the upper deck's portion will be offset to approximate the place where the ladder exits. Draw each end of the ladder on its appropriate s-layer as a polyline compartment making sure that the two polylines overlap. The overlap between the two compartments should be approximately 2' wide by 3' long. These two compartments will be considered as one, and both portions will have the SAME plan ID - the one assigned to the LOWER end of the ladder - to indicate that these two polylines represent the same compartment. Insert **DOOR** blocks at the appropriate end of each polyline to indicate the access. A **DOOR** block is required even for an open doorway. Example: Figure K-4(a).

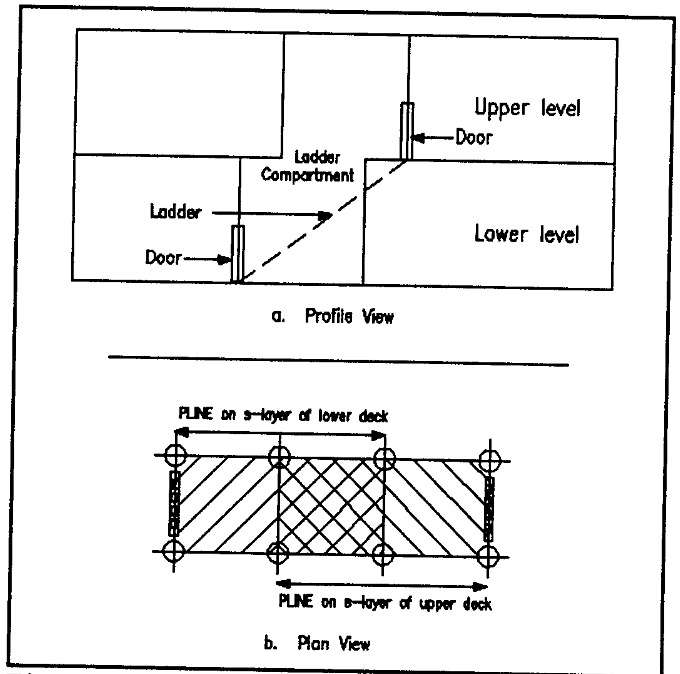

Figure K-4 Class IV Ladders

Class IV ladder compartments (compartments on upper and lower levels) should be aligned as shown in Figure K-4(b), with port and starboard bulkheads aligned and fore and aft bulkheads staggered.

NOTE: **DOOR** blocks should be **INSERT**ed at the appropriate ends of all ladder compartments, whether there is a door or an open doorway there.

V. Particularly on larger ships, a stair tower may exist, spanning multiple decks as illustrated by Figure K-5(a). The simplest and most accurate way to model this situation is through a series of reduced-height and enclosing compartments. Figure K-5(b) illustrates the profile view and Figure K-5(c) depicts the plan view. Note that an enclosing compartment on the lower level shares its Plan ID with a reduced-height compartment on the level above. The reduced-height compartments must be given the appropriate height in Section III.F.3. Appropriate **DOOR** blocks should be added to SHIP.DWG where they exist on both the enclosing and reduced-height portions of the compartment.

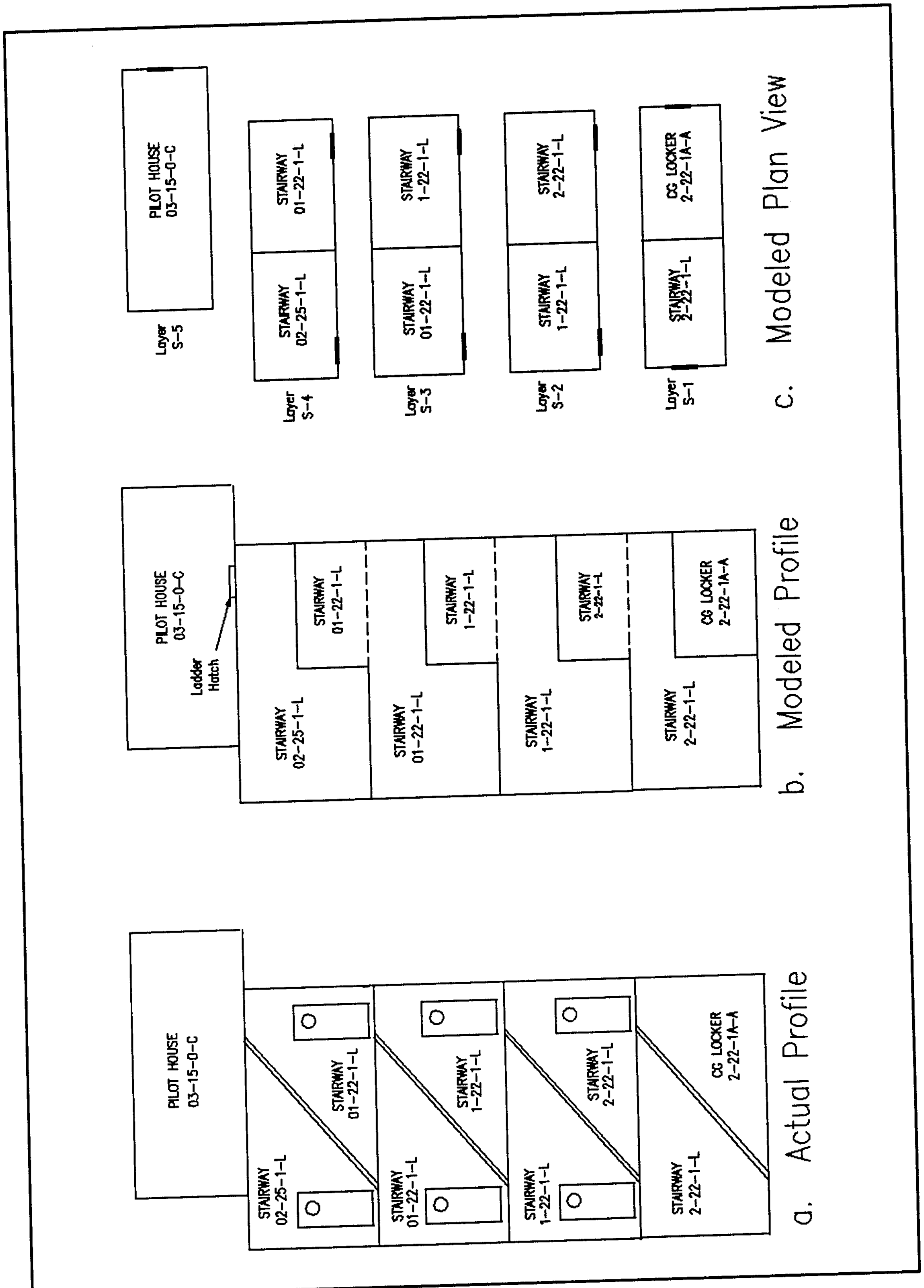

Figure K-5 Class V Ladders

Type III, IV and V ladders may include a small compartment or gear locker in the dead space of the ladder's closed end, as shown in Figure K-6(a). The locker will be given a reduced-height in Section III.F.3 causing the ladder's overhead to be the combined area of the ladder and the locker even though its deck area is smaller. Figure K-6(a) shows an "exploded" view of how the two polylines should be drawn and Figure K-6(b) illustrates a profile of how the ladder and locker will actually be represented in SHIP.dwg.

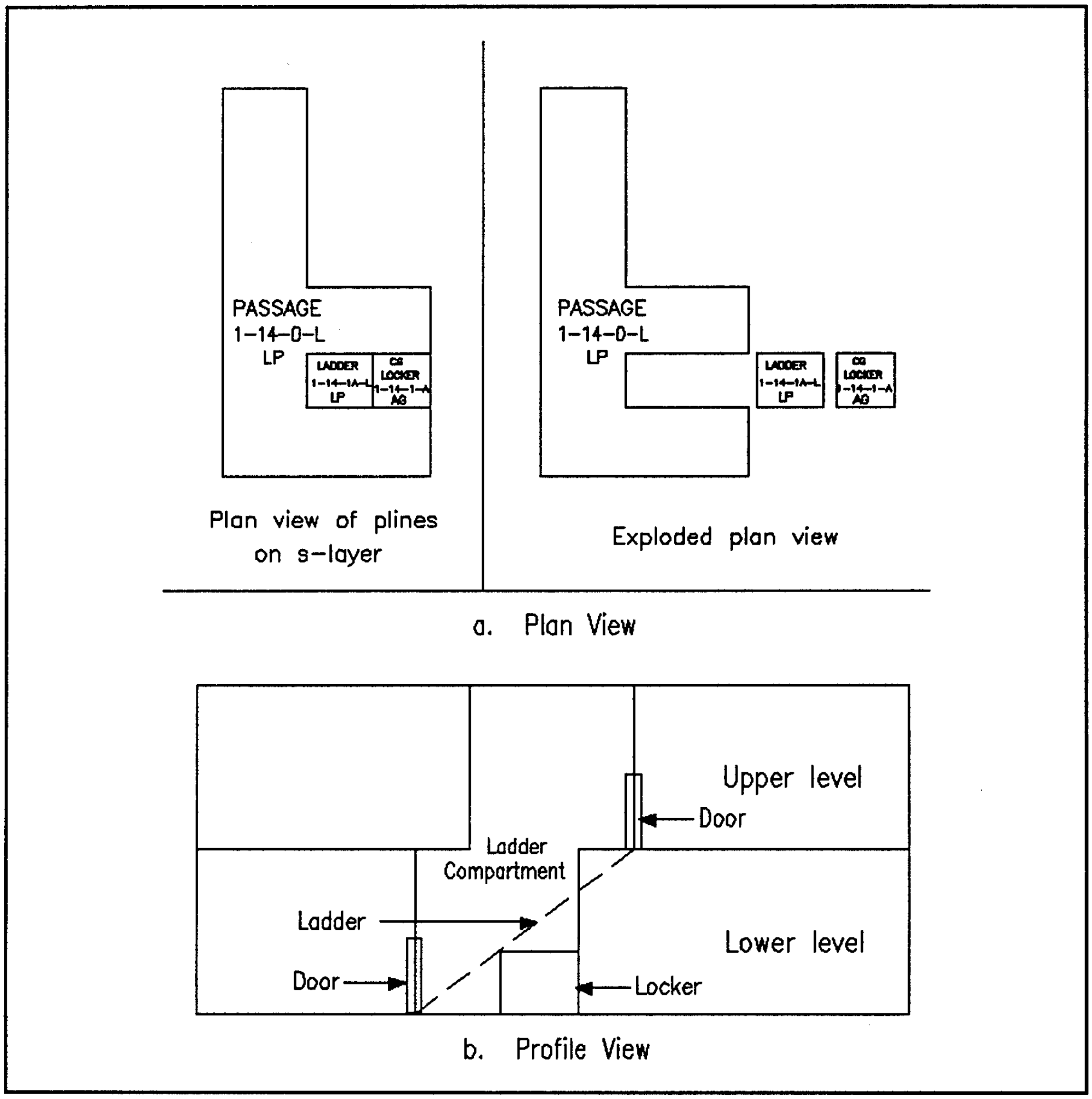

Figure K-6 Example of Locker Under Ladder

APPENDIX L

COMBINING BARRIER MATERIALS IN BULKHEADS

The method used for combining barrier materials in SAFE Version 2.2 was derived using the engineering judgment of SAFE's developers and is subject to refinement in future versions of SAFE.

In SAFE Version 2.2, a single bulkhead is assigned up to three barrier materials from the list in Appendix A:

- A weather bulkhead must have assigned an exterior material and an interior facing material even if it is the same as the exterior material. (1 to 2 different materials)

- An interior (non-watertight) bulkhead must have a facing material on each side which may or may not be the same material. (1 to 2 different materials)

- An interior watertight bulkhead must have a "core" watertight material and a facing material on each side of the core even if it is the same material as the core. (1 to 3 different materials)

SAFE considers the properties of all **unique** materials in the analysis of the bulkhead. If the **same** barrier material is entered for each side of a bulkhead (and for the core if it is a watertight bulkhead), SAFE uses the properties of this one barrier material, not two or three. But if two (or three) **different** materials are assigned to a bulkhead, or if the **same** material is separated by a **different** material, such as the watertight core, then the properties of **all** materials assigned are taken into account.

The properties printed in Appendix A for each barrier material are utilized by SAFE in both the FRI time calculation and the running of the probabilistic model.

APPENDIX L

FOR FULL ROOM INVOLVEMENT TIME CALCULATION:

The algorithm utilized to calculate Full Room Involvement time (FRI time) estimates when a fire's growth in a compartment allows the compartment's temperature to exceed 500 degrees Celsius over ambient. A key factor in this determination is the amount of heat loss which is experienced through the compartment's barriers. Since the barrier's insulating properties control its ability to hold or lose heat, it is the barrier material's insulating properties of density, specific heat, thermal conductivity, and thickness that are used to calculate FRI time. If two or three barrier materials are assigned to a bulkhead, the values assigned to these properties are combined as follows to arrive at one value for each property:

If a bulkhead is assigned an insulated barrier material, any non-insulated barrier materials assigned to that bulkhead are ignored. The density, specific heat and thermal conductivity values of the insulated materials are averaged and their thicknesses are summed to arrive at one value for each of these properties for the bulkhead.

However, if **no** insulated barrier materials are assigned to a bulkhead, then the density, specific heat, and thermal conductivity values of all the materials are averaged and their thicknesses are summed to arrive at one value for each of these properties for the bulkhead.

(A barrier material with a thermal conductivity < 40.0 (W/mK°) is considered to be insulated.)

FOR THE PROBABILISTIC MODEL:

Each barrier material's thermal and durability strength are defined by two "curves" as discussed in the *Theoretical Basis*, Chapter 6.3.4.2. and printed in Appendix A. The probabilistic model uses these Tbar and Dbar "curves" to determine when a barrier fails thus allowing EB in the adjacent space, then uses the barrier material's percent heat release value to determine how much heat energy is passed through the failed barrier.

If a bulkhead is assigned more than one barrier material, the model program selects the Tbar curve of the barrier material with the largest Tbar point (x3) and selects the Dbar curve and percent heat release value of the barrier material with the largest Dbar point (x3) to represent the barrier.

APPENDIX M

AUTOCAD GLOSSARY

The phrase "**COMMAND**: prompt" refers to the standard AutoCAD prompt displayed whenever AutoCAD is awaiting user input from keyboard or other input device.

LAYER MANIPULATION: All SAFE utilities are designed to manipulate layers using the **LAYER FREEZE** and **THAW** options instead of **ON** and **OFF**. Do not turn layers **OFF** to make them invisible - use **FREEZE** so the programs will be able to function properly when called.

A. SAFE PROTOTYPE DRAWING DESCRIPTIONS

ULTIMATE.DWG:

This prototype drawing is used to create the drawing containing the final set of ship plans used in SAFE, 'SHIP.DWG'. It is based on the standard AutoCAD prototype drawing, ACAD.DWG, described in the *AutoCAD Reference Manual*. Changes from the standard values are described below:

Grid:	On, spacing 1.0
Layer:	0,...,9, color white
	s-1,...,s-9 odd nos. color red, even nos. color green.
	b-1,...,b-9 color white
	all linetypes continuous
Limits:	Off, drawing limits (0,0) to (120,90)
Point:	PDMODE 34, PDSIZE 0.5
Snap:	On, spacing 0.2
Style:	Style STANDARD, using font ROMANS, variable ht., width factor 0.75
Text:	Style STANDARD, height 0.2
Trace:	Width 0.025
Units:	Decimal feet, two decimal places

Entity Creation Modes: Color & text BYLAYER, elev & thickness 0.0.
All other values are the same as described for acad.dwg.

APPENDIX M

Blocks included with ULTIMATE.DWG

BARR: Interior barrier block, marked by a symbol (PDMODE 67)
Attributes: serial no., plan id #1, material #1, plan id #2, material #2, thermal adjustment, durability adjustment, door types.

WBARR: Watertight barrier block, marked by a symbol (PDMODE 67)
Attributes: serial no., watertight material id, plan id #1, material #1, plan id #2, material #2, thermal adjustment, durability adjustment, door types.

SBARR: Exterior barrier block, marked by a symbol (PDMODE 67)
Attributes: serial no., plan id, exterior material id, interior material id, thermal adjustment, durability adjustment, door types.

OBARR: Overhead barrier block, marked by a symbol (PDMODE 67)
Attributes: serial no., plan id #1, material id, plan id #2, thermal adjustment, durability adjustment, hatch types.

TBARR: Weather overhead barrier block, marked by a symbol (PDMODE 67)
Attributes: serial no., plan id, material id, thermal adjustment, durability adjustment, hatch types.

DOOR: generic polyline to mark door locations. See Figure M-1.

HATCH: generic polyline to mark hatch locations. See Figure M-2.

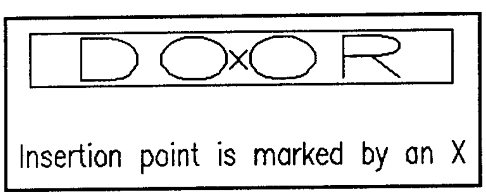

Figure M-1 Door Block

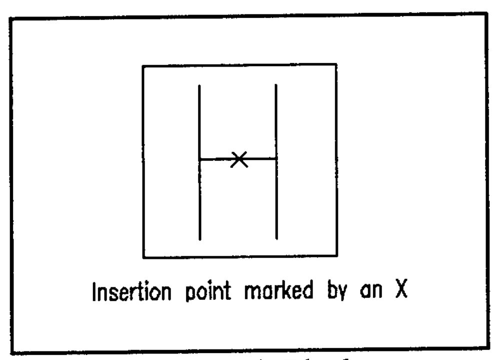

Figure M-2 Hatch Block

COLORS.DWG:

This prototype drawing is used to display SAFE graphic reports in AutoCAD. It, too, is based on the standard prototype ACAD.DWG. Changes are described below.

Grid:	On, spacing 0.5
Styles:	Style STANDARD, using font ROMANS, variable ht., width factor 0.75
	Style THIN, using font ROMANS, variable ht., width factor 0.6.
Text:	Style STANDARD, height 0.2

All other values are the same as described for ACAD.DWG.

Blocks included in COLORS.DWG: CRANGE2, CRANGE3, CRANGE4, CRANGE5: used as keys for compartment graphic reports showing colors or hatch patterns used to depict user-assigned ranges in the report. See Figure M-3.

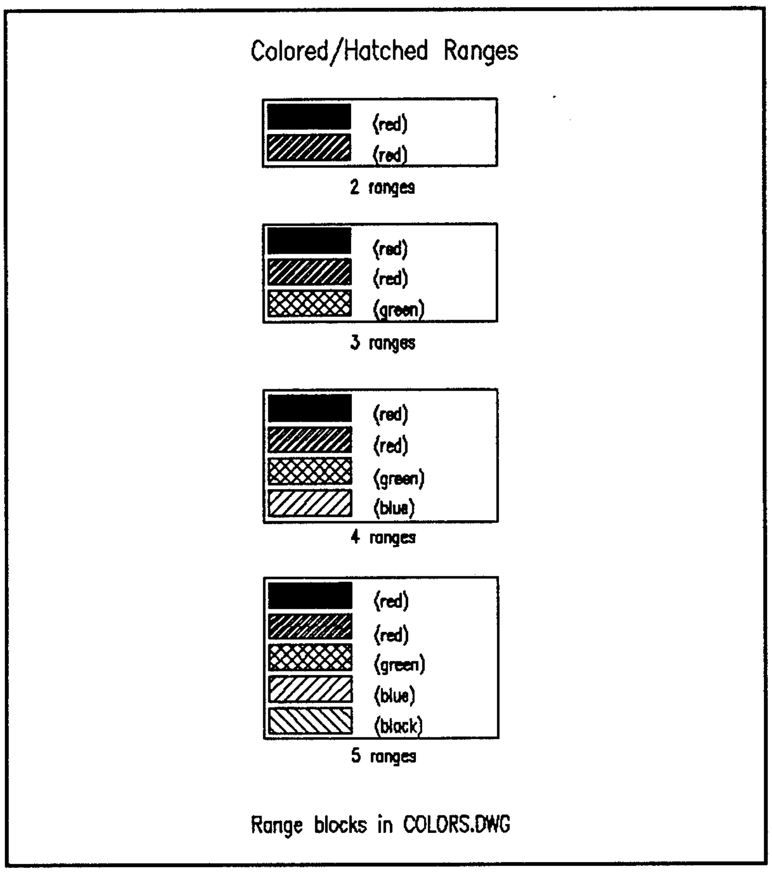

Figure M-3 Range Blocks in COLORS.DWG

B. ULTIMATE DRAWING FORMAT

General: SHIP.DWG, created from ULTIMATE.DWG prototype. Scale is 1 unit=1 foot, decimal feet.

Decks: Simplified plan of deck #1 on layer s-1, etc. One s-layer for each deck. Deck name is included on the s-layer. Centerline with frame ticks may appear on layer 0.

Compartments: One closed polyline representing each compartment. Segments of the polyline which are perpendicular or parallel to the centerline must be drawn EXACTLY straight. Compartment contains compartment name, plan ID, compartment use indicator (CUI). Door blocks inserted in polylines to indicate all door locations. Compartments sharing vertices must have their polyline vertices **OSNAP**ped to the same **NODE** (point marker).

C. AutoCAD COMMANDS USED

The AutoCAD commands mentioned in the *SAFE User Manual* are listed here. Refer to Rel. 11 or Rel 12 of the *AutoCAD Reference Manual* for more information.

<u>COMMAND (options)</u>

CHANGE (properties: layers, thickness, elevation (rel. 12))
DIST
DDATTE (multiple)
DDLMODES
DXFOUT (entities)
DDEDIT
END
ERASE
EXPLODE
ID
INSERT
LAYER (set, freeze, thaw)
LIMITS
MOVE

OOPS
OSNAP (intersection,node,none)
PAN, 'PAN
PLAN
PLINE (close,edit)
PLOT, PRPLOT (rel. 11)
POINT
PURGE
QUIT
SAVE
STATUS
TEXT/DTEXT (left-justified)
UCS/DDUCS
VIEW (restore)
WBLOCK
ZOOM, 'ZOOM (all, dynamic, extents)
Object Selection Options: WINDOW,CROSSING,ADD,REMOVE

NOTE: Object selection options and **OSNAP** modes are used in conjunction with many of the other commands listed above.

D. SAFE AutoLISP UTILITIES

There are several AutoLISP utilities included with the SAFE package in the file ACAD.LSP which is stored in the \SAFE\IO directory. This ACAD.LSP file should not interfere with any other ACAD.LSP file on the system. These utilities were created to aid the process of converting ship plans to the ultimate drawing format and to provide an interface between AutoCAD and the database. These utilities and their use are documented below.

NOTE: Many of the utilities described below are called automatically by the SAFE Menu, not by the user. These are marked by an asterisk (*). DO NOT enter the marked utilities at the COMMAND: prompt.

*ATTRIBS: Called automatically from the SAFE Menu when the default barrier data file has been created by the database. Once SHIP.DWG is opened by the SAFE Menu, BARR, SBARR, WBARR, TBARR, and OBARR blocks are inserted at the correct locations and the attributes are filled with the default data for tailoring. This is run only once per ship. See Section IV.C.5.1.6.

*COLORS: Called automatically when a compartment graphic report is chosen from a SAFE Menu. This program opens COLORS.DWG and plots the desired report using the ranges supplied by the user. See Sections VI.A.3, VI.F.1, and VI.G.1.3.

COUNTCOMPS: Called by the user prior to using DXFLAYER to allow the user to number the compartments on the paper plans in the same order they will be "dxf-ed". It also tells the user how many plines are on the layer to compare with the number which the user recorded. See Section III.F.3.

D1 (Display1): Called by the user to display one layer and freeze all others.

To use:
- Type **D1** at the COMMAND: prompt.
- Enter the name of the desired layer:
  Disregard the "Cannot freeze..." message.

D2 (Display2): Called by the user to display two layers, setting one as the current layer.

To use:
- Type **D2** at the **COMMAND:** prompt.
- Enter the name of the layer to display as current:
- Enter the name of the other layer to display:

  Disregard the "Cannot freeze..." message.

D3 (Display3): Called by the user to display three layers, setting the first one entered as the current layer. This is used when tailoring o-layers (overhead barriers and hatches) as described in Section IV.C.5.2.

To use:
- Type **D3** at the **COMMAND:** prompt.
- Enter the name of the lower o-layer to display: {use o-, NOT 0-}
- Enter the name of the lower b-layer or s-layer to display:
- Enter the name of the upper b-layer or s-layer to display:

  Disregard the "Cannot freeze..." message.

DXFLAYER: Called by the user after compartment polylines on the s-layers are completed in Section III.F. This routine guides the user through the process of creating a .dxf file of each s-layer in the format required by the database to ensure the text entities (plan ID, name, CUI) associated with each compartment are loaded into the database in the correct sequence. This routine and its prompts are described in detail in Section III.G. This routine is also used in Section IV.C.1.1.

To use:
- **D1** to s-1
- Type **DXFLAYER** at the **COMMAND:** prompt.
- Select the deck name when prompted.
- The first compartment polyline found on the s-layer will be displayed in white. Follow the prompts to select the text associated with that compartment polyline. When text selection for that compartment is complete, the option to re-do that compartment is presented.
- When the first compartment is completed, the next compartment polyline will appear in white. Follow the prompts to select its associated text. Repeat for each compartment polyline on the s-layer. When all polylines on the s-layer have been selected, the .dxf file will be closed.
- When the **COMMAND:** prompt reappears, **D1** to the next s-layer, issue the **DXFLAYER** command again, and repeat the process for this s-layer. Repeat for each s-layer.

EXTRACTS: Called by the user when tailoring of the barrier blocks is complete. This creates standard AutoCAD extract files to be used for updating the database. This can be run repeatedly until the extract files pass through the checking program with no errors and are loaded into the database. See Section IV.C.5.2.3.

To use: ♦ Type **EXTRACTS** at the **COMMAND:** prompt.
No additional user input required.

MOVEIT: Called by the user to change all selected entities to a user-specified layer. See Section III.C.2.1.

To use:
- ♦ Type **MOVEIT** at the **COMMAND:** prompt.
- ♦ **WINDOW** around desired entities.
- ♦ Enter the desired layer name.

PICKWT: Called by the user to pick watertight barriers on layers below the main deck. See Section IV.C.1.2.3 for complete documentation for its use.

*PLOTBARS: Called automatically by SAFE to plot the locations of watertight and stepped barriers in SHIP.DWG just before ATTRIBS is run. This is run only once per ship. See Section IV.C.5.2.

REDOWT: Called by user to redo selection of watertight barriers if a mistake was made in PICKWT procedure described above.

RESCALES: Called by the user to change the drawing scale and units of a drawing to 1 unit = 1 decimal foot. This changes the **UNITS** setting of the drawing. See Section III.C.3.2.

To use:
- ♦ Type **RESCALES** at the **COMMAND:** prompt.
- ♦ Enter the scale multiplier (from the AutoCAD worksheet) to four decimal places. After the drawing is rescaled, it will automatically **ZOOM EXENTS**.
- ♦ Issue the **LIMITS** command and enter new limits compatible with the new drawing size.

RESTART: Called by the user to remove the barrier tailoring blocks from SHIP.DWG. This procedure should ONLY be used when a user wishes to change the geometry of a ship and begin an analysis again after revising the SHIP.DWG drawing file. This procedure is necessary only if the barrier tailoring blocks have been loaded into SHIP.DWG.

SETZ: Called by the user to set an entire layer's elevation and thickness before running DXFLAYER command. See Section III.F.3.

*UPDATES: Called automatically from the SAFE Menu if changes are made to Plan IDs or blanket changes are made to barriers in the database. A file of these changes is created by the database automatically, and the next time SHIP.DWG is opened, this program is run automatically to update the barrier blocks. See Section IV.C.2 and V.E.

*VERIFIES: Called automatically from the SAFE Menu after the ship's barriers are calculated. Once SHIP.DWG is opened by the SAFE Menu, the calculated barriers are drawn on b-layers which correspond to the s-layers. The user is responsible for verifying that the calculated barriers are correct as drawn. This will be run each time new barriers are calculated. See Section IV.C.1.2.

APPENDIX N

MODIFYING SHIP GEOMETRY

SAFE's developers have attempted to provide maximum flexibility for the analyst to modify as many characteristics of a ship as possible at any time in the analysis. This allows the ship's baseline to be correctly modeled and the fire safety of an alternative to be tested by modifying the ship's data set and running the probabilistic model to compare "before and after" results. Unfortunately, modifying ship geometry is the one area where SAFE is necessarily inflexible.

Modifying the geometry is defined as changing the x,y coordinates of compartment polylines or the z coordinate as expressed by the compartment elevation and thickness as established in SHIP.DWG. Because the compartment's coordinates are used to calculate the connectivity between compartments, changes to geometry would cause a complete reconfiguration of the barriers contained in the database. Even the compartments themselves, which are assigned a serial number that is invisible to the user, will not necessarily be assigned the same serial number after the geometry changes as they were before the change. Thus, in order to alter a ship's geometry, the analyst must essentially "begin again" in performing a ship fire safety analysis. If the analyst is convinced that this is necessary, this appendix is designed make the job easier.

IF THE GEOMETRY IS BEING MODIFIED **BEFORE** THE DATABASE IS LOADED WITH COMPARTMENT AND BARRIER DATA. . .

Starting again at this stage of the analysis (before filling the database as described in Section IV.C.4-5) can be quite painless. Sections IV.C.1.3 and IV.C.2.5 define situations where it is possible to make changes to the ship's geometry.

Exit SAFE and look in the \SAFE\IO directory for the presence of files ending in "*.SAV" by executing the following MS-DOS commands:

```
CD \SAFE\IO
DIR *.SAV
```

If any such files exist, rename them so that they end in *.DXF:

```
REN *.SAV *.DXF
```

See the explanation below entitled "Reusing .DXF files" before re-entering SAFE and selecting "Prepare AutoCAD Drawing" from the Main Menu.

IF THE GEOMETRY IS BEING MODIFIED **AFTER** THE DATABASE IS LOADED WITH COMPARTMENT AND BARRIER DATA. . .

If the geometry is to be modified after the database is loaded with compartment and barrier data (Section IV.C.4 and IV.C.5), it is recommended that the altered geometry be treated as if it were a new ship and be given a new codename. The existing ship should be archived as described in Chapter VII and "Enter a New Ship" should be selected from the opening SAFE menu. The user will be asked to enter basic ship information for the new ship including a new 3-4 letter code name. Then exit SAFE after the SAFE Main Menu appears.

Next, copy the SHIP.DWG file from the archived ship to \SAFE\IO directory so that it may be used as a basis for the altered ship. If the archived ship has a ship codename of XYZ, then the archived ship's SHIP.DWG file will be located in the directory \SAFE\XYZ\FINAL. At the MS-DOS prompt type:

COPY \SAFE\XYZ\FINAL\SHIP.DWG \SAFE\IO

Also note if there are any files ending in "*.SAV" in the archived ship directory. If so, read "REUSING .DXF FILES" below and copy the ".SAV" files to the \SAFE\IO directory, renaming them ".DXF". The following MS-DOS command may be used to copy these potentially reuseable files.

COPY \SAFE\XYZ\FINAL\1.SAV \SAFE\IO\1.DXF

After the copy is complete and all reuseable ".DXF" files have been placed in \SAFE\IO, re-enter SAFE and select "Prepare AutoCAD Drawing".

If the archived ship's SHIP.DWG file has already been loaded with barrier blocks for tailoring (See Section IV.C.5.2), a SAFE command available in AutoCAD called **RESTART** may be used to delete all barrier tailoring blocks and white and yellow lines marking stepped and watertight barriers drawn on the s-layers.

Then the changes to the geometry may be made to the SHIP.DWG file. New ".DXF" files must be made using the **DXFLAYER** command for any layers where changes were made or a ".DXF" file wasn't restored from a ".SAV" file.

APPENDIX N

REUSING .DXF FILES

A ".SAV" file, which was renamed ".DXF", is the latest complete ".DXF" file created for a layer of the ship.

If a ".SAV" file does not exist for a given layer, this indicates that the last time that layer was ".DXFed" out, it was for a partial layer, not a complete one.

For example, let's assume ".DXF" files for the three decks of an archived ship were created by the user using the **DXFLAYER** command as complete layers and were processed successfully by SAFE. These files were named "1.DXF", "2.DXF", and "3.DXF" by SAFE and were saved as "1.SAV", "2.SAV", and "3.SAV" after they were processed because they were complete layers.

Due to an error in one compartment on the bottom deck (layer 1), this layer "was re-DXFed" as a partial layer containing only the one compartment in error and ignoring all others. This files was also called "1.DXF". Because it was only a partial layer whose corrections rendered the saved "1.SAV" no longer valid, "1.SAV" was deleted. After this correction, connectivity was generated and the database was loaded.

Now let's assume that a geometry change needs to be made to the top deck (layer 3). We found "2.SAV" and "3.SAV" in the archived ship's directory and we have renamed them "2.DXF" and "3.DXF" in \SAFE\IO. Since layer 3's geometry needs correcting, the entire layer must be "re-DXFed" and "3.DXF" is of no use. Since the last "DXF" file from layer 1 was only a partial file, there is no "1.SAV". The entire layer s-1 must be "re-DXFed" also. However, "2.SAV" exists and is still valid, so we will NOT have to "reDXFout" layer 2.

Thus, the user will only have to create new ".DXF" files for layers of the ship where geometry changes are being made OR for layers where there were no ".SAV" files saved and renamed to ".DXF".

APPENDIX O

SAFE MENU MAP

This appendix presents a flow diagram of the SAFE menu system. This "menu map" is divided into menu blocks which generally correspond to the options on the SAFE Main Menu. The top of each menu block is a double-lined box. Arrows are used to direct the user to another menu block.

Most of the titles in the individual boxes correspond to actual menu titles, which in turn correspond to the titles of chapters and section of the *SAFE User Manual.*

The figures in this appendix correspond to the following chapters:

Figure	Menu Blocks	Refer to
O-1	Select Ship to Analyze	Chapter II
	Demo Ship Main Menu	Section II.B
	SAFE Main Menu	Chapter II-VI
O-2	Load Database with Ship Data	Chapter IV
	Enter Compartment/Barrier Data	Section IV.C
O-3	Assign and Tailor Barrier Values	Section IV.C.5
O-4	Run Probabilistic Model	Chapter V
O-5	Modify the Current Data Set	Chapter V.E
O-6	View/Print Reports & Forms	Chapter VI

APPENDIX O

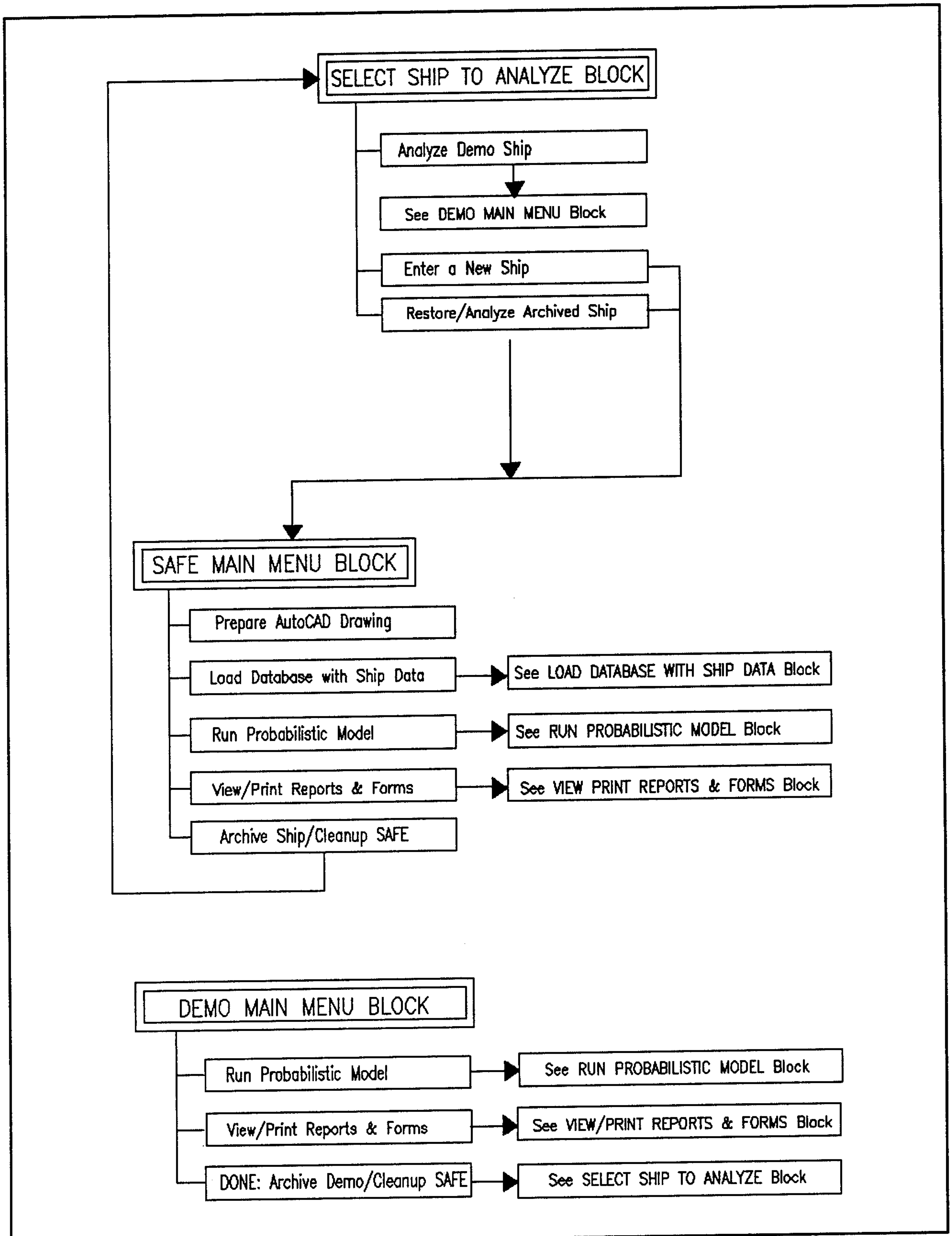

Figure O-1 Menu Map - Main and Demo Menu Block

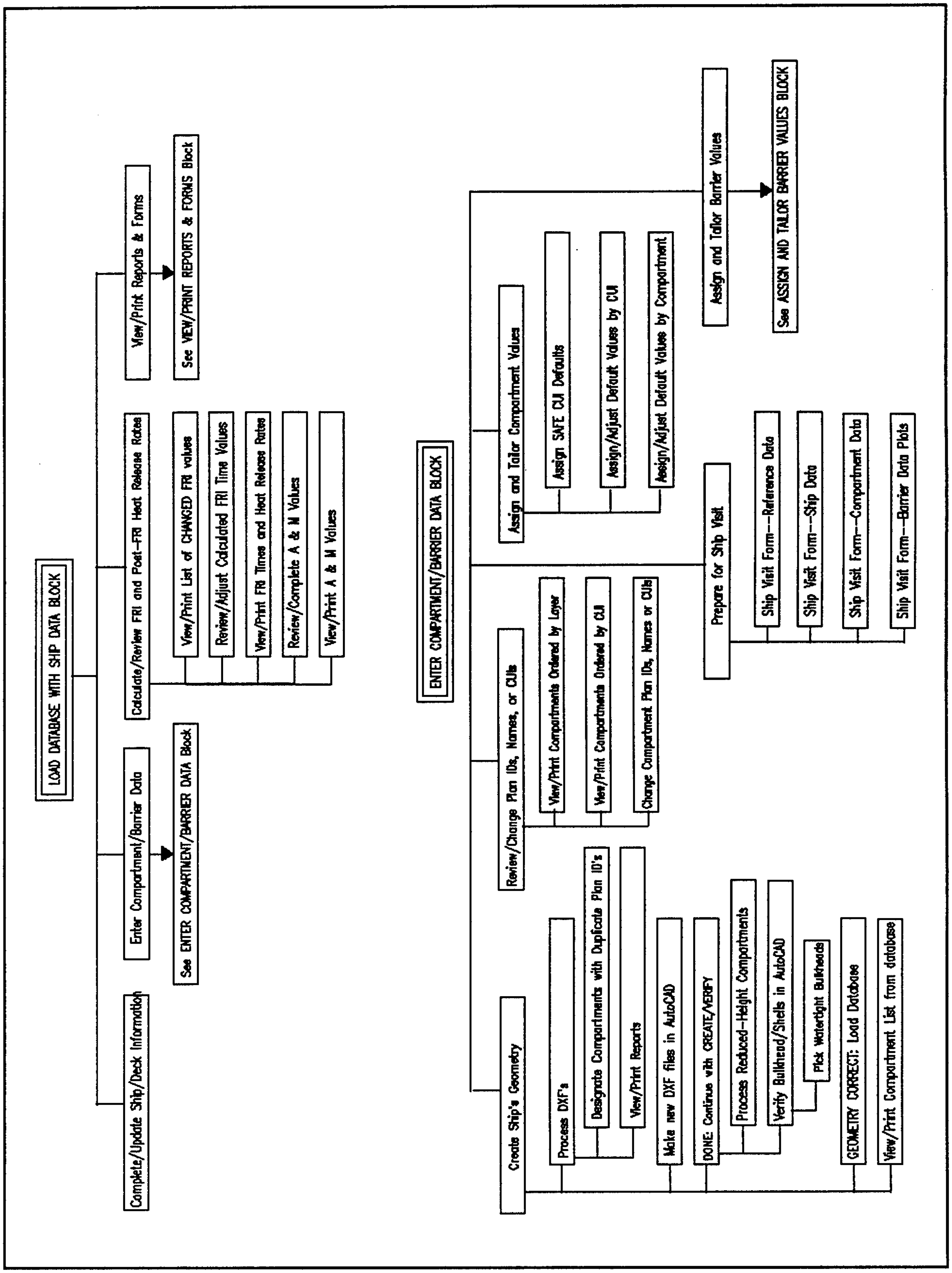

Figure O-2 Menu Map - Load Database with Ship Data Block

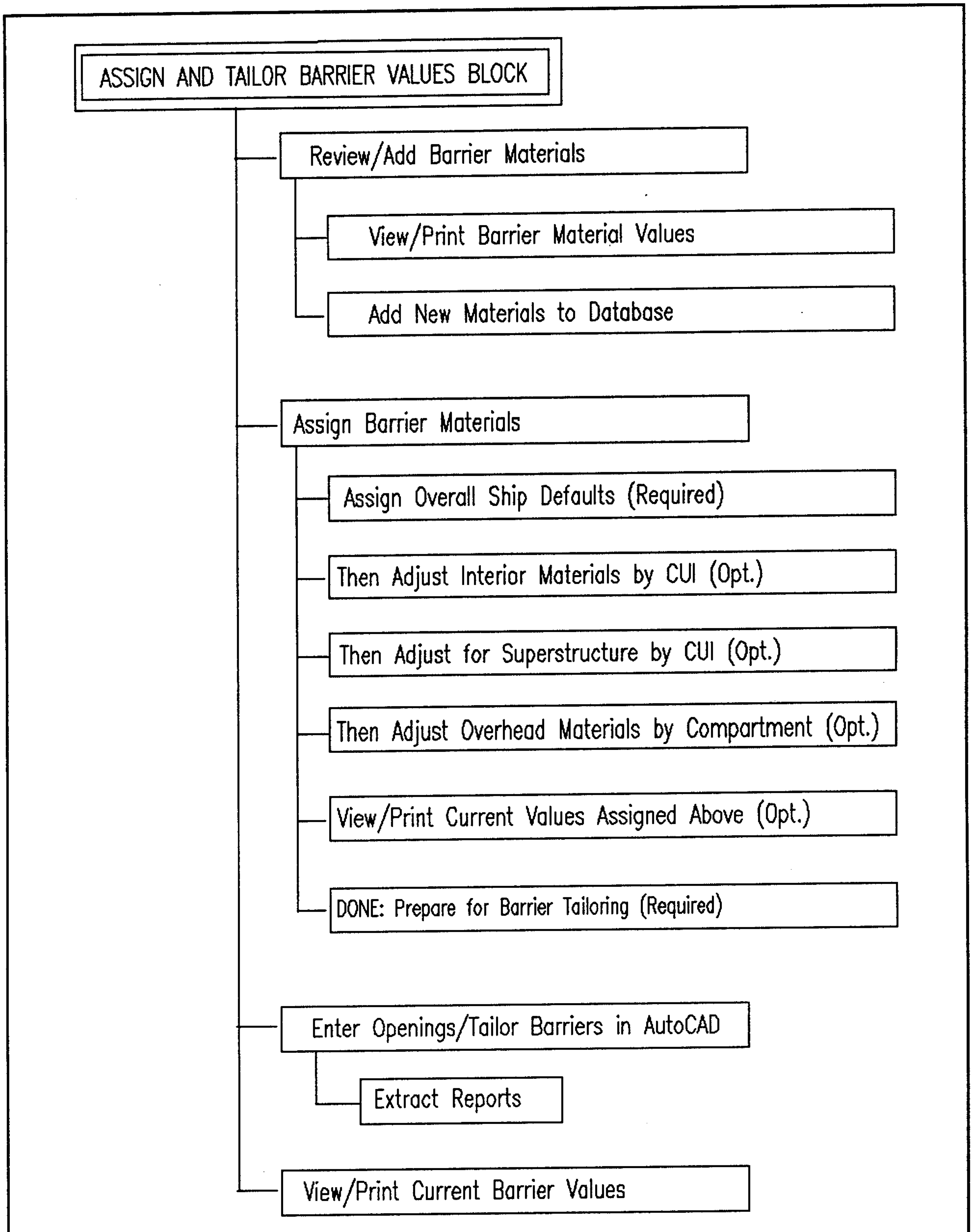

Figure O-3 Menu Map - Assign and Tailor Barrier Values Block

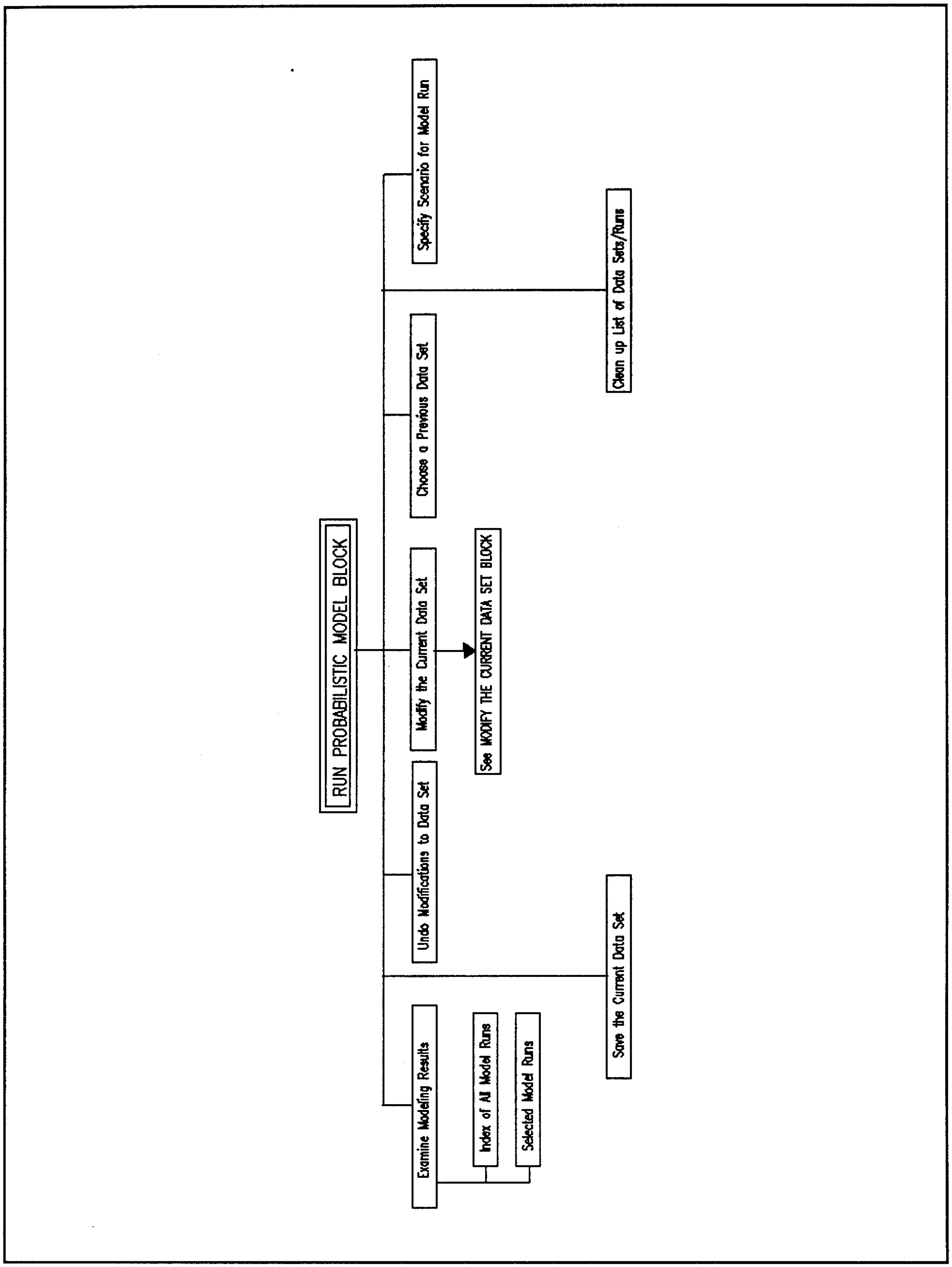

Figure O-4 Menu Map - Run Probabilistic Model Block

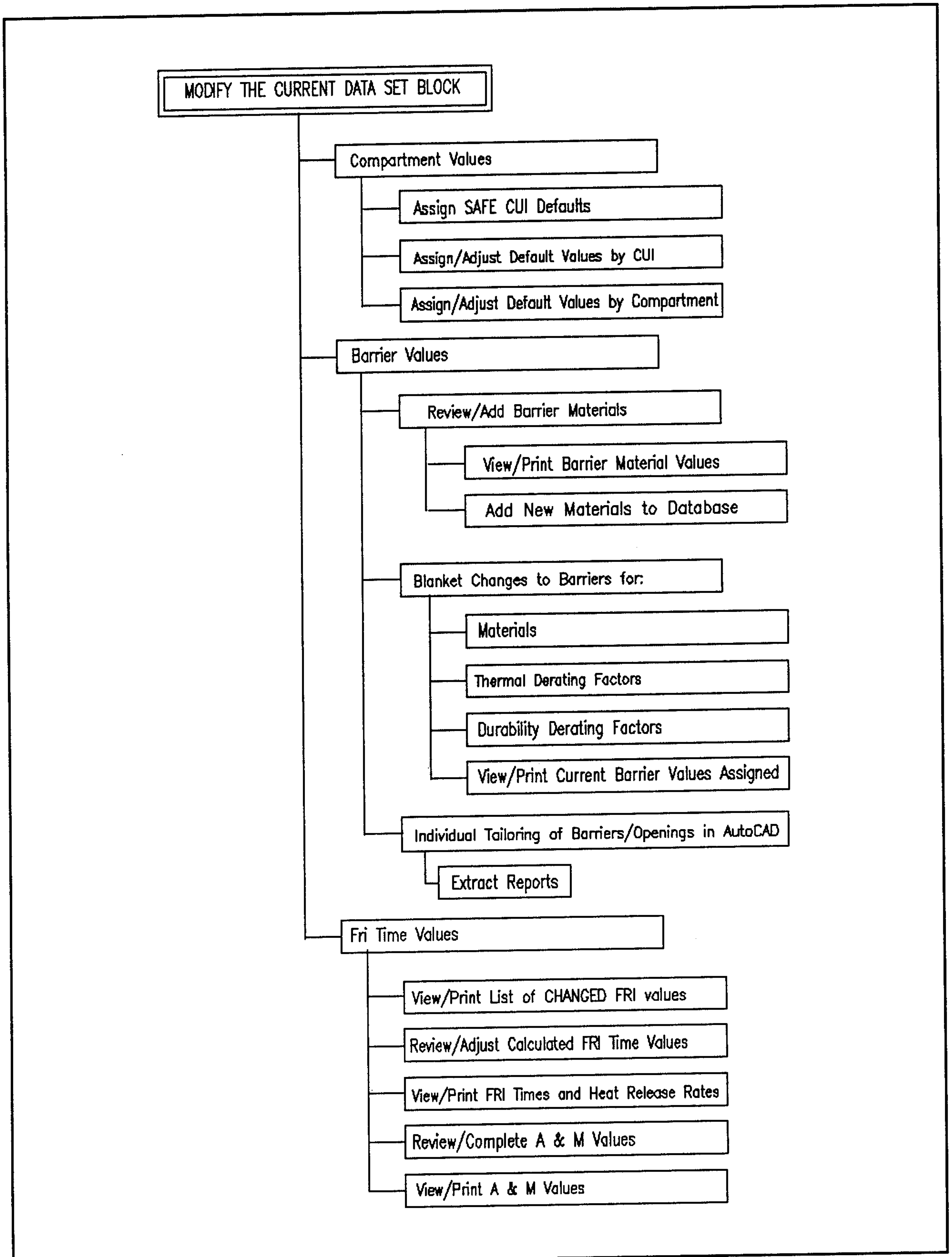

Figure O-5 Menu Map - Modify the Current Data Set Block

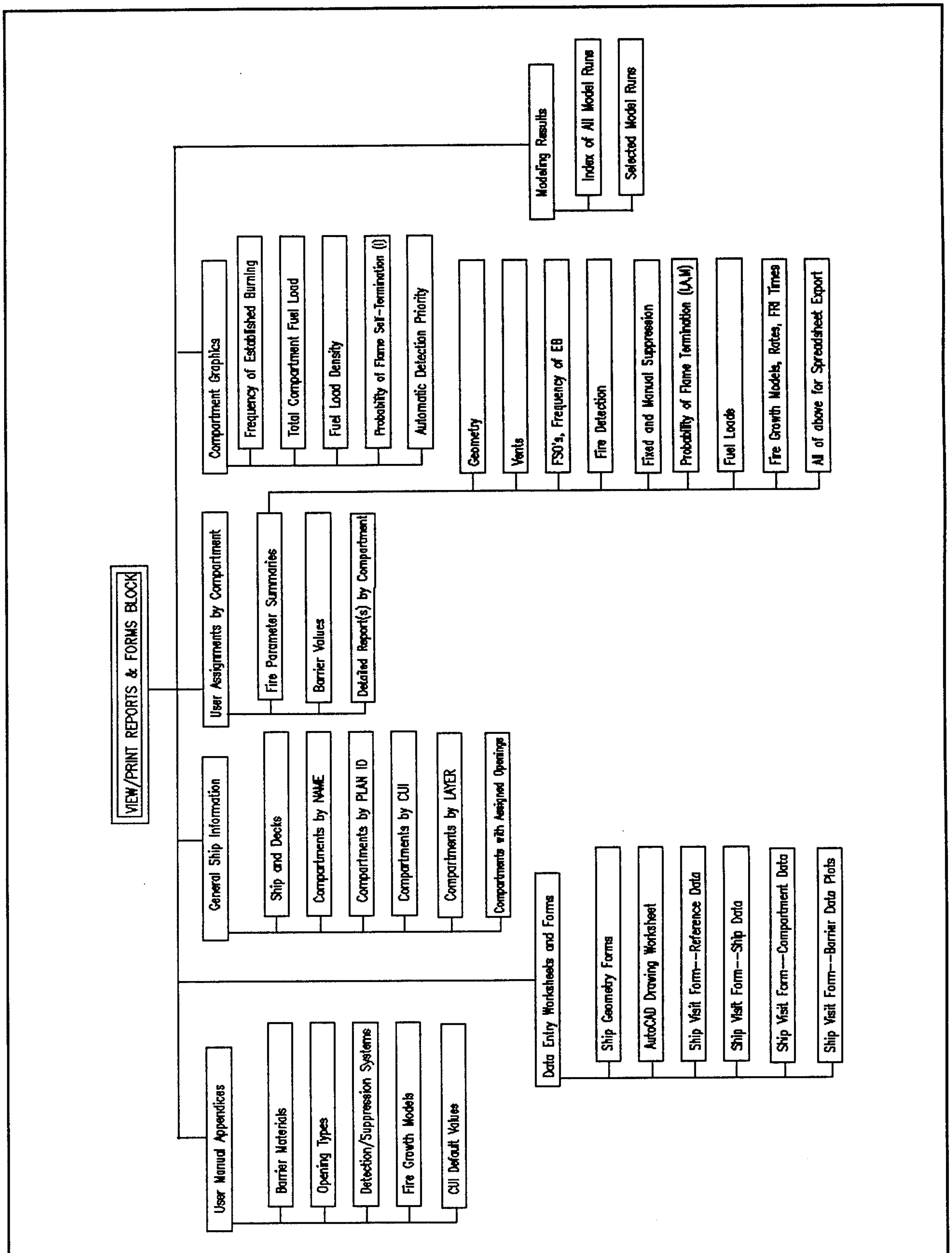

Figure O-6 Menu Map - View/Print Reports and Forms Block

APPENDIX P

ALTERING A PRINTER'S SYMBOL SET

In order to determine if your printer is correctly set to ensure SAFE's printed reports will be properly formatted, cd \SAFE\BIN from the DOS prompt and print a sample file called "prt-test.out" which is stored there.

Lines per page: If the two pages of the sample file both begin with a header of "PRINTER TEST", and the last line on the first page says that it is the last line on the first page, then your printer's lines/page need not be changed.

Symbol set: If there is an empty table with lines outlining the table's cells like the following, then your printer's character set need not be changed.

If neither the lines per page nor the symbol set needs to be adjusted, the remainder of this appendix may be ignored. Otherwise, read on.

Other software packages (word processors, Windows software, etc.) will control the printing of information produced by them, so any changes that you make to the lines/page or the symbol set will just control output from DOS applications like SAFE.

Look in the index of your printer manual under "lines per page" to alter this parameter to 66 when SAFE is in use.

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Look in the index of your printer manual under "character sets", "extended characters" or "symbol sets" for instructions on setting the printer's symbol set. Usually, a set of tables are printed in the printer manual.

You must select the set with the following symbols for Hexadecimal address B0 - DF:

	B	C	D
0	░	└	╨
1	▒	┴	╤
2	▓	┬	╥
3	│	├	╙
4	┤	─	╘
5	╡	┼	╒
6	╢	╞	╓
7	╖	╟	╫
8	╕	╚	╪
9	╣	╔	┘
A	║	╩	┌
B	╗	╦	█
C	╝	╠	▄
D	╜	═	▌
E	╛	╬	▐
F	┐	╧	▀

Some printers offer a user friendly program to change these parameters. (The HP LaserJet 4L, for example, has the HPExplorer.) Other printers may allow these change to be made from the control panel on the printer's front, or by altering dip switches. Most printers can be controlled by sending escape sequences to them, and very cryptic messages are usually provided in the back of the printer's manual for accomplishing this. This option can be problematic and should be used only by knowledgeable computer professionals.

If you have difficulty making either of these adjustments, SAFE's reports will still print. If the lines/page are incorrect, SAFE's reports will not be correctly paginated, and page headings will not appear at the top of each page as they should. If the symbol set is incorrect, the columns and rows may be separated by odd characters other than the lines which normally would be used as separators.

GLOSSARY

LIST OF ABBREVIATIONS AND TERMS

Active Fire Protection - Fire protection features designed to limit the flame movement by automatic detection, automated fixed fire extinguishing systems, and manual suppression systems or equipment. Examples of active fire protection features are: automatic sprinkler systems, fire extinguishers, and trained firefighting teams. See "Passive Fire Protection".

A value - The probability that an automated fixed fire protection system installed in a compartment will successfully extinguish the fire before FRI occurs. See "I value" and "M value."

Alpha - The fire growth rate (in kilowatts/second^2) used to calculate the pre-FRI heat release rate or Q (in kilowatts). Generally, within SAFE, alpha is set to 0.001 for slow growth, 0.01 for moderate growth, 0.1 for fast growth and 1.0 for ultra-fast fire growth. Engineering judgment is used to select alpha and intermediate values are frequently used. See "Pre-FRI Heat Release Rate."

Alternative Data Set - Data sets identified as "Alternative" have had the baseline input values to SAFE adjusted as necessary to reflect the impact of the proposed alterations or modifications which affect the ships' fire safety system. See "Baseline Data Set."

Automatic Detection Priority - A value assigned to each compartment based on a fire detection value calculated as:

freq.EB * max{% UNmonitored at sea, % UNmonitored in port} * FAL/MAL

This value provides a means of prioritizing the automatic detection needs of the ship's compartments.

Baseline Data Set - Data sets identified as "Baseline" utilize input values to the SAFE program based on the physical condition of the ship found during the ship visit and are not influenced by any modifications or alterations which may be proposed as a result of an analysis. See "Alternative Data Set."

Beyler/Peatross Algorithm - The algorithm used in SAFE Version 2.2 to calculate FRI-time for compartment fires. Primary variables include heat release rate, heat loss through the boundaries and the incoming air. See "FRI Time".

GLOSSARY

CBO - Compartment Burnout - The point in the fire growth curve where exhaustion of all fuel due to pyrolysis occurs.

CO_2 - Carbon Dioxide. A firefighting agent particularly effective against class C fires.

Condition of Readiness - One of three damage control conditions of readiness set by the Commanding Officer of a military ship. All accesses such as doors and hatches, and other fittings are labelled X, Y, or Z. In condition Xray, all Y and Z accesses and fittings are assumed open and X are closed; in condition Yoke, all Z accesses and fittings are assumed open and X and Y are closed; in condition Zebra, all accesses and fittings are closed.
In addition, SAFE has added the following ratings:

> NC (Normally Closed) for joiner doors or windows which are assumed closed in all readiness conditions.
>
> NO (Normally Open) for joiner doors or windows which are assumed to be open in all but condition Zebra.
>
> O (Open) for open doorways or hatchways which can not be closed.

CUI - Compartment Use Indicator - The designation for a compartment selected from a list provided in SAFE used to define the type or function of the compartment and establish default values for various fire parameters.

D Adjust - A user defined parameter that can range from 0 to -99% to derate the Dbar values for a barrier to account for deterioration or penetrations of the barrier. See "Dbar".

Data Set - A data set describes those characteristics of a ship which affect its performance as a fire safety system. It includes information describing particular aspects of each compartment such as geometry, construction, fuel type and load, automatic detection and monitoring systems, ventilation and fire protection systems.

D - The probability that a barrier will not fail due to durability or massive failure (equals 1-Dbar).

Dbar - The probability that a barrier will fail due to durability or massive failure (equals 1-D).

Dbar Control Points - Three values of heat energy impact of increasing magnitude plotted on the X axis corresponding to probabilities of barrier durability failure of 0, 0.5, and 1.0 plotted on the Y axis. These points define a barrier material's Dbar curve.

GLOSSARY

DC Readiness Condition - See Condition of Readiness

EB - Established Burning - The point in the fire growth curve between ignition and FRI when the fire starts to grow exponentially with respect to time. EB is usually considered equivalent to a flame 10" high. EB also signifies the demarcation between fire prevention and the beginning of the ship's response to the fire.

FAL - See "Frequency of Acceptable Loss"

Fire Growth Model - One of 16 models of fire growth defined in SAFE that describe the characteristics of the fuel load in a compartment. The fire growth model determines the fire growth rate (alpha) and the maximum heat release rate (Qmax). See "Alpha" and "Qmax".

Fire Safety System - A term used to address the overall performance of a ship as it relates to fire safety. It considers the ship as a whole and accounts for such things as compartment geometry, construction, fuel type and load, automatic detection and monitoring systems, ventilation and fire protection systems.

FLLR - Flammable Liquid Line Rupture. A scenario used in SAFE to model a class B spray fire. The key user defined variables include the room of origin where the rupture occurs, the amount of fuel that is added to the compartment's fuel load as a result of the rupture, and the room of origin's associated FRI time and I value.

Frequency of Acceptable Loss (FAL) - The frequency with which a compartment can sustain a given Magnitude of Acceptable Loss (MAL). The FAL and MAL together establish the FSO's for a given compartment. See "MAL" and "FSO's".

Frequency of EB - The frequency with which compartments of a given CUI experience Established Burning. SAFE's default values for frequency of EB are based on historic fire casualty data compiled from data provided by the U.S. Naval Safety Center and the Coast Guard's MISREP mishap reporting system.

FRI - Full Room Involvement - The point in the fire growth curve when the temperature in a compartment has increased 500 degrees Celsius above ambient. FRI conditions include surface burning of all combustibles, and survival for unprotected personnel is not possible.

FRI Time - The elapsed time (in minutes) from EB to FRI calculated in SAFE using the Beyler-Peatross algorithm.

GLOSSARY

FSO's - Fire Safety Objectives - Performance standard ideally established by cognizant authorities for a compartment accounting for mission protection, property protection and life safety. The SFSEM is designed to analyze, quantify and compare the ship's performance as a fire safety system to achieve the established FSO's on a compartment by compartment basis. The FAL and MAL together establish the FSO's for a given compartment. See "FAL" and "MAL".

Ignition - Point in the fire growth curve that denotes the beginning of pyrolysis of combustible fuel.

I value - The probability that the fire will self-extinguish at some point between EB and FRI.

L curve - A curve which plots the cumulative probability of limiting the flame on the Y axis (on a logarithmic scale) against time or deck area of the compartment on the X. Convention calls for plotting 0 probability of limiting the flame at the top of the Y axis and 100% probability of limiting the flame at the origin of the Y axis.

MAL - Magnitude of Acceptable Loss - The a rating of one to four that defines the severity of damage that can be tolerated in a compartment. FAL and MAL together establish the FSO's for a given compartment. See "FAL" and "FSO's".

Material Condition of Readiness - See Condition of Readiness

M value - The probability that manual firefighting efforts will successfully extinguish the fire before FRI occurs.

Non-Standard Scenario - Similar in all respects to a Standard Scenario except that it considers reduced levels of available fire protection systems.

Passive Fire Protection - Fire protection features designed to limit the flame movement by their presence alone. Barriers are the best example of passive fire protection, intumescent coatings, fire doors, fuel load distribution, and insulation of hot surfaces are other examples. See "Active Fire Protection".

Percent Heat Release (%) - The percentage of heat that will transfer through a barrier into the adjacent compartment in the event of a Dbar failure.

GLOSSARY

PKP - Potassium bicarbonate. A dry chemical firefighting agent frequently used in portable fire extinguishers. The only authorized dry chemical portable fire extinguisher permitted on board Coast Guard Cutters.

Post-FRI Heat Release Rate - (in kilowatts) A calculated rate of heat released from the burning fuel in a compartment fire which has achieved full room involvement. In SAFE, this value is calculated using the ventilation factor, $A*H^{.5}$, which takes into account the height and area of the ventilation opening. The numerical coefficient used in the formula (1500) assumes stoichiometric burning conditions.

Pre-FRI Heat Release Rate - (in kilowatts) A calculated rate of heat released from the burning fuel in a compartment fire before the compartment has achieved full room involvement. In SAFE, the primary variables in this calculation include the fire growth coefficient, alpha, and time^2. Also known as Q.

Qmax - (kilowatts) The maximum permissible value of the heat release rate. Qmax is a function of the fire growth model. See "Fire Growth Model".

RLF - Relative Loss Factor - RLF's are calculated in SAFE as a means of assessing whether a target compartment or set meets FSO's. An RLF > 1 indicates that a compartment has failed to meet FSO's. This factor is determined by multiplying the target's relative frequency of loss given fire free state (calculated during a given run of SAFE) by the assigned FAL. A target is considered lost if its level of fire involvement for a given path exceeds the level specified by its MAL rating.

SAFE - Ship Applied Fire Engineering - The computerized implementation of the SFSEM.

Scenario - A situation defined by the user before executing a SAFE probabilistic model run. Such parameters as run time, ship location, material condition of readiness and firefighting configuration are specified.

SFSEM - The Ship Fire Safety Engineering Methodology. A probabilistic-based risk analysis methodology used to analyze all aspects of the ship's performance in response to a fire compared to pre-established FSO's.

Standard Scenario - Scenarios used to define a ship's response to fire under the different operating conditions experienced by the vessel with full fire protection capabilities available.

GLOSSARY

Stepped Deck - That portion of a deck which is not in the same horizontal plane as the majority of the deck, creating bulkheads that connect compartments on two adjacent decks.

Stoichiometric - A term that describes ideal burning which assumes there is sufficient oxygen to ensure 100% combustion of available fuel.

T Adjust - A value that can range from 0 to -99% that is applied to the Tbar value of a specified barrier to account for deterioration or thinning of the barrier.

T - The probability that a barrier will not fail due to thermal or hot spot failure (equals 1-Tbar).

Target - a compartment or set of compartments which are analyzed in a model run to determine their likelihood of being lost to a fire. (See RLF.)

Tbar - The probability that a barrier will fail due to thermal or hot spot failure (equals 1-T).

Tbar Control Points - Three values of heat energy impact of increasing magnitude plotted on the X axis corresponding to probabilities of barrier thermal failure of 0, .5, and 1.0 plotted on the Y axis. These points define a barrier material's Tbar curve.

Ventilation Factor - A factor, $A*H^{.5}$, that describes the primary variables in the post-FRI heat release rate calculation in SAFE. These variables are the total area and average height of the ventilation opening(s) in a compartment.

XRAY, YOKE and ZEBRA - Damage Control Readiness Conditions. Successively increasing readiness conditions for controlling damage. At each level, additional access closures, valves and fittings are required to be closed to limit fire and flooding. (See Condition of Readiness.)

Zero-Strength Barrier - A barrier that has no fire resistance. Used to model extremely long passageways and connect compartments with no physical barrier (engine rooms and their uptakes).

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